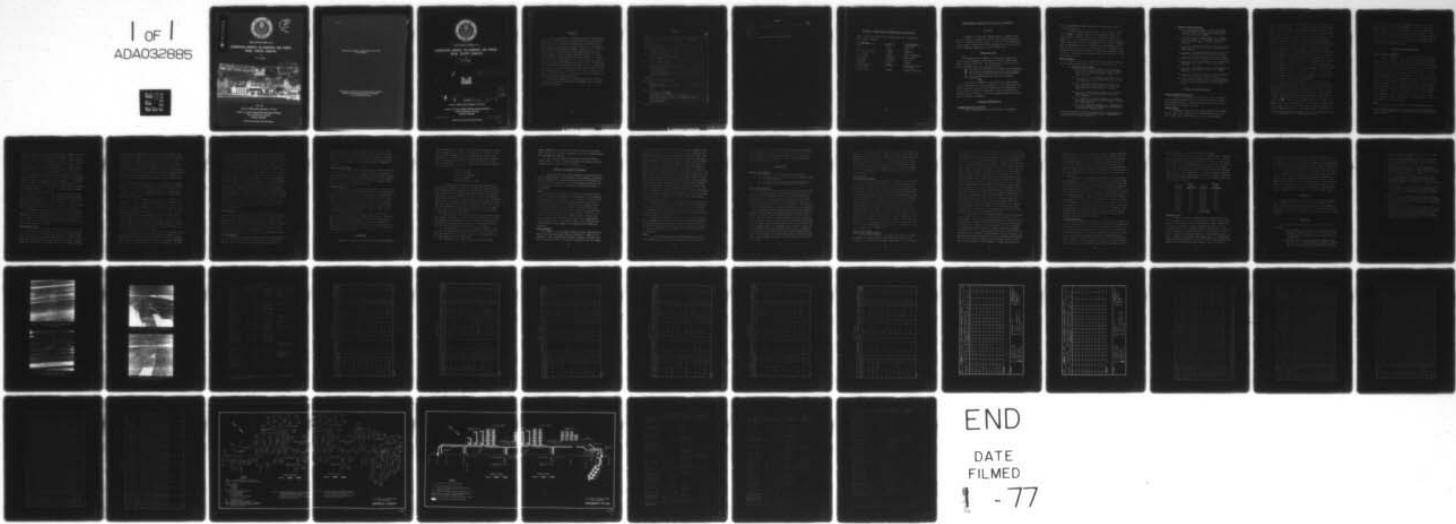


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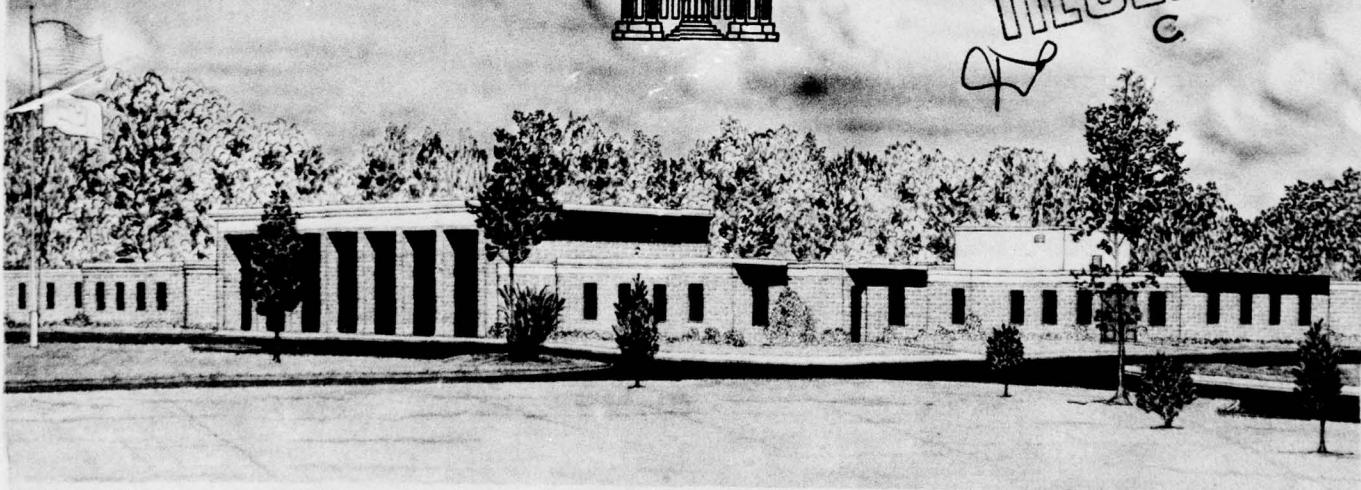
MISCELLANEOUS PAPER S-73-12

CONDITION SURVEY, ELLSWORTH AIR FORCE BASE, SOUTH DAKOTA

by

P. J. Vedros

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April 1973

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Conducted by U. S. Army Engineer Waterways Experiment Station
Soils and Pavements Laboratory
Vicksburg, Mississippi

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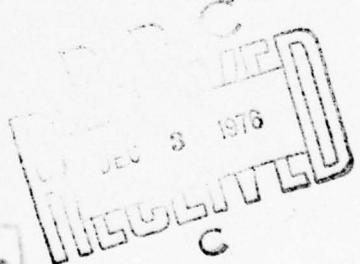
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Foreword

The study reported herein was conducted under the general supervision of the Engineering Design Criteria Branch, Soils and Pavements Laboratory, of the U. S. Army Engineer Waterways Experiment Station (WES), Vicksburg, Mississippi. Personnel from the U. S. Army Cold Regions Research and Engineering Laboratory (CRREL), Hanover, New Hampshire; the U. S. Army Construction Engineering Research Laboratory (CERL), Champaign, Illinois; and the WES participated in this study. Personnel involved in the condition survey were Messrs. P. J. Vedros, R. D. Jackson, H. T. Thornton, Jr., S. J. Alford, and K. A. O'Connor of the WES; T. C. Johnson of CRREL; and G. Schanz of CERL. The main text of this report was prepared by Mr. Vedros under the general supervision of Messrs. J. P. Sale, R. G. Ahlvin, and R. L. Hutchinson of the Soils and Pavements Laboratory. The section of the report concerning frost action was prepared by Messrs. Johnson and G. D. Gilman of CRREL. Appendix A was obtained from the Air Force.

COL Ernest D. Peixotto, CE, was Director of the WES during the conduct of the study and preparation of the report. Mr. F. R. Brown was Technical Director.

Contents

	<u>Page</u>
Foreword	iii
Conversion Factors, British to Metric Units of Measurement	vii
Authority	1
Purpose and Scope	1
Pertinent Background Data	1
General description of airfield	1
Previous reports	2
History of Airfield Pavements	3
Design and construction history	3
Traffic history	3
Conditions of Pavement Surfaces	5
Pavement inspection procedure	5
Runway	5
Primary taxiway system	6
Operational apron	8
SAC alert facility	8
NW and SE warm-up aprons	9
Secondary facilities	9
Maintenance	9
Comparisons of Pavement Performances	11
Runway	11
Primary taxiways	11
Aprons	12
Frost Action	13
Objectives of inspection	13
Frost heave of pavements	13
Thaw weakening of subgrades or base courses	14
Pavement performances versus frost condition criteria	14
Design freezing index	16
Groundwater table	17
Evaluation	18

Contents

	<u>Page</u>
Conclusions	18
Tables 1-4	
Photos 1-4	
Plates 1 and 2	
Appendix A: EAFB Annual Pavement Maintenance Plan	

Conversion Factors, British to Metric Units of Measurement

British units of measurement used in this report can be converted to metric units as follows:

<u>Multiply</u>	<u>By</u>	<u>To Obtain</u>
inches	2.54	centimeters
feet	0.3048	meters
miles (U. S. statute)	1.609344	kilometers
square inches	6.4516	square centimeters
square yards	0.8361274	square meters
pounds (mass)	0.45359237	kilograms
kips (mass)	453.59237	kilograms
pounds (force) per square inch	0.6894757	newtons per square centimeter
miles per hour	1.609344	kilometers per hour

CONDITION SURVEY, ELLSWORTH AIR FORCE BASE, SOUTH DAKOTA

Authority

1. Authority for conducting condition surveys at selected airfields is contained in amendment to FY 1972 RDTE Funding Authorization (MFS-MC-5, 16 February 1972), subject: "Air Force Airfield Pavement Research Program," from the Office, Chief of Engineers, U. S. Army, Directorate of Military Construction, dated 18 February 1972.

Purpose and Scope

2. The purpose of this report is to present the results of a condition survey performed at Ellsworth Air Force Base (EAFB), South Dakota, during 6-9 April 1972. The following three major areas of interest were considered in this condition survey:

- ① (1) The structural condition of the primary airfield pavements.
- ② (2) The condition of pavement repairs and the types of maintenance materials that have been used at this airfield.
- ③ (3) Any detrimental effects of frost to the pavement facilities.

3. This report is limited to a presentation of visual observations of the pavement conditions, discussion of these observations, and pertinent remarks with regard to the performance of the pavements. No physical tests of pavements, foundations, or patching materials were performed during this survey. The annual pavement maintenance plan for EAFB is presented in Appendix A.

Pertinent Background Data

General description of airfield

4. EAFB, formerly Rapid City Air Force Base, is located in

Pennington and Meade Counties, South Dakota, approximately 6 miles* northeast of Rapid City.

5. In April 1972, the airfield facilities consisted of a NW-SE (12-30) runway, a parallel taxiway, a large operational apron, two warm-up aprons, a connecting taxiway to the runway and aprons, nine hangar access taxiways and aprons, two washracks, a missile loading facility, and an alert facility. The runway was 300 ft wide and 13,497 ft long; the operational apron was 850 ft wide and approximately 4,160 ft long; and the taxiways were 100 ft wide, except for a 75-ft-wide taxiway through the old ADC alert apron. A layout of the airfield is shown in plate 1. A pavement plan indicating the type pavement on each facility is shown in plate 2.

Previous reports

6. Previous reports concerning EAFB are listed below. Pertinent data were extracted from them for use in this condition survey.

a. Condition survey reports.

- (1) Ohio River Division Laboratories, CE, "Preliminary Report on Rigid Pavement Condition Survey of Rapid City Air Force Base, South Dakota," August 1947, Cincinnati, Ohio.
- (2) _____, "Report of Rigid Pavement Condition Survey, Rapid City Air Force Base, South Dakota," July 1950, Cincinnati, Ohio.
- (3) U. S. Army Engineer Division, Missouri River, CE, "Rigid Pavement Condition Survey of Ellsworth Air Force Base, South Dakota," April 1956, Omaha, Nebraska.
- (4) _____, "Rigid Pavement Condition Survey, Ellsworth Air Force Base, South Dakota," June 1959, Omaha, Nebraska.
- (5) U. S. Army Engineer District, Omaha, CE, "Report of Investigation of Flexible Airfield Pavement," October 1959, Omaha, Nebraska.
- (6) Ohio River Division Laboratories, CE, "Condition Survey Report, Ellsworth Air Force Base, South Dakota," February 1965, Cincinnati, Ohio.

* A table of factors for converting British units of measurement to metric units is presented on page vii.

b. Pavement evaluation reports.

- (1) U. S. Army Engineer Division, Missouri River, CE, "Pavement Evaluation Report, Rapid City Air Force Base, Rapid City, South Dakota (Evaluation No. I)," December 1944, Omaha, Nebraska.
- (2) U. S. Army Engineer District, Omaha, CE, "Pavement Evaluation Report No. II, Ellsworth Air Force Base, Rapid City, South Dakota," October 1955, Omaha, Nebraska.
- (3) _____, "Pavement Evaluation Report No. III, Ellsworth Air Force Base, South Dakota," November 1956, Omaha, Nebraska.
- (4) _____, "Pavement Evaluation Report No. IV, Ellsworth Air Force Base," July 1957, Omaha, Nebraska.
- (5) _____, "Pavement Evaluation Report No. V, Ellsworth Air Force Base," December 1957, Omaha, Nebraska.
- (6) _____, "Airfield Evaluation Report, Ellsworth Air Force Base, South Dakota," November 1959, Omaha, Nebraska.
- (7) _____, "Airfield Evaluation Report, Ellsworth Air Force Base, South Dakota," December 1960, Omaha, Nebraska.
- (8) _____, "Airfield Evaluation Report, Ellsworth Air Force Base," January 1962, Omaha, Nebraska.
- (9) Civil Engineering Center, Wright-Patterson Air Force Base, "Airfield Pavement Evaluation Report, Ellsworth Air Force Base, South Dakota," June 1971, Dayton, Ohio.

History of Airfield Pavements

Design and construction history

7. Details of the design and construction history of the airfield pavements (extracted from the reports referenced in paragraph 6) are presented in table 1. Pavement thicknesses, descriptions, and other details are presented in table 2.

Traffic history

8. A detailed traffic record was not available for this study; however, some traffic information was available from previous condition surveys and pavement evaluations. B-52 aircraft started

operating at EAFB in March 1957. Prior to that time, the heaviest aircraft using the field was the B-36. It was estimated that, in the last three years of operations by B-36 aircraft, approximately 7,000 coverages of channelized traffic were applied on the primary taxiway. Traffic at that time averaged about 1,000 cycles* per month, of which 40 percent was from fighters; 20 percent, C-124; 20 percent, B-36; and 20 percent, miscellaneous aircraft. During the period April 1957-March 1958, there were 404 cycles of B-47 traffic, 317 cycles of B-52 traffic, 23 cycles of KC-97 traffic, 178 cycles of C-124 traffic, and 6,239 cycles of miscellaneous aircraft traffic. From April-August 1958, a total of 454 cycles of B-52 traffic were applied. Traffic records for the period April-May 1959 indicate that 230 cycles of B-52, 3 cycles of KC-97, 11 cycles of KC-135, 23 cycles of C-124, and 800 cycles of miscellaneous aircraft traffic were applied. The average number of cycles per month during March-May 1964 was 585 for transports, cargoes, and tankers; 360 for fighters; and 89 for B-52's. Traffic records for heavy aircraft during the period 1 January 1971-31 December 1971 indicate that the total number of cycles was as follows: 1, C-5A; 96, C-141; 1,961, KC-135; 612, EC-135; and 828, B-52. The operating load of the B-52 for a basic mission was 410,000 lb; operating loads for the KC-135 and the EC-135 were 235,000 and 260,000 lb, respectively.

9. Based on the above information, it is estimated that there have been approximately 10,000-12,000 cycles of B-52 traffic applied to the airfield pavements at EAFB. The SE runway end is used for approximately 75 percent of the takeoffs and landings. The primary taxiway leading to this end of the runway and the runway end have, therefore, received approximately 5,000 coverages of channelized traffic from B-52 aircraft. Some portions of the apron taxiway receive 100 percent of these operations. Taxiway 26 (the primary taxiway to the NW end of the runway), which has developed distress at the joints, has received about 1,500 coverages from B-52 aircraft. The takeoff weight of these aircraft has averaged 400,000 lb. It was reported that, at present, about

* A cycle of operation is one landing and one takeoff.

8 to 10 practice alert aircraft per month taxi down the length of the runway, travel along the primary taxiway, and return to the parking stubs. The aircraft weigh about 488,000 lb during these exercises. These movements have not been included in the total number of cycles listed above. Assuming that these practice alerts have been occurring since B-52's have been at the field, there have been approximately 700 additional coverages of this heavy load applied on the full length of the runway and primary taxiway system.

Conditions of Pavement Surfaces

Pavement inspection procedure

10. The following procedure was used in conducting the inspection of the rigid pavements. Representative features were selected for detailed inspection. The features were then inspected slab* by slab, and the defects were recorded. The locations of the individual pavement features, the inspection starting points, and the directions in which the pavements were inspected (shown by arrows) are indicated in plate 1. The results of the rigid pavement survey for those features that were inspected in detail are presented in table 3. This table shows a quantitative breakdown of the various types of defects and a condition rating for each pavement feature inspected in detail. The procedures used for determining the condition rating of a pavement are given in Appendix III of Department of the Army Technical Manual TM 5-827-3, "Rigid Airfield Pavement Evaluation," dated September 1965. The pavement defect identified as a keyed joint failure in table 3 was not included in the reference manual, because this type defect has only recently been observed. It results from traffic by extremely heavy aircraft and is considered to be a major defect.

Runway

11. In general, the condition of the pavement surface on the

* A slab is the smallest unit, containing no joints, of a given pavement feature.

runway was considered to be excellent. The 1000-ft runway ends were in excellent condition with only two major structural defects recorded (table 3). The 75-ft inlay section of the interior portion of the runway from sta 40+06 to 65+06 (features RL2C, RL4C, and RL5C), which consisted of 18-in. reinforced portland cement concrete (PCC), had nine slabs that contained transverse cracks. The crack openings were very small and appeared to be held tightly together by the reinforcement (photo 1). The condition of this inlay section was rated as good.

12. An asphaltic concrete (AC) overlay was placed on the runway from sta 135+30 to 160+03 in 1966 and from sta 65+06 to 135+30 in 1969; and, at the time of this survey, the overlay pavement was in excellent condition. There was evidence of some reflection cracking at the joints, with some free water in the cracks, probably from frost melting. The overlay was feathered at sta 165+03, and the edges of the overlay were raveling at this point (photo 2).

13. The 17-in. PCC in the center 50 ft of the runway from sta 135+30 to 155+03 was replaced with 19-in. PCC in 1963 due to failures that had been experienced in the 17-in. pavement. The surface of the 19-in. PCC was reported to have become rough and an AC overlay was placed in 1966 to correct this condition. It was not possible to determine the performance of the 19-in. PCC because of the AC overlay.

14. Structurally, the pavements seem to be performing satisfactorily under the loads imposed by the B-52's now using the pavements. Sixteen B-52 pilots and thirty-six KC-135 pilots were asked to rate the riding quality of the runway, and only five B-52 pilots rated it as rough. The roughness was indicated to be on the northwest end of the runway, especially during landings.

Primary taxiway system

15. The primary taxiway system consists of taxiways 26, 21, and 17. The northwest end of taxiway 26 (feature T1A), which was constructed in 1956, was designed for channelized traffic of 100,000-lb wheel loads. The outer lanes are 19 in. thick, and the center lane is 22 in. thick, with a transition between the center and outer lanes. A condition survey performed in 1959 reported that, at that time, approximately

40 slabs contained longitudinal spalls that were the result of keyed joint failures. During the 1972 survey, it was estimated that approximately 163 slabs in the center lane contained longitudinal spalls that were considered to have resulted from keyed joint failures. These failed areas have been sawed out and replaced by hot-mix AC patches. The patches vary in length from several feet to the full length of a slab, and frequently the joints on both sides of the slab require patching. There were 23 slabs in this taxiway that had been replaced because they had reached a shattered condition. This feature was rated as being in fair condition, based on the defects that were recorded in the 1972 survey.

16. The next portion of taxiway 26 (feature T2A) is of flexible pavement construction. This area had developed distress from B-52 operations, so the center 50 ft of the taxiway was overlaid with 4 to 6 in. of AC in 1971. At the time of this survey, this feature was in excellent condition, with no evidence of grooving or cracking from the heavy aircraft operations.

17. The portion of taxiway 26 adjacent to the operational apron (feature T4A), which was constructed in 1953 of 21-in.-thick PCC, is 100 ft wide. Failures occurred in the two middle lanes, and, in 1963, the Air Force replaced the center 50 ft of this taxiway with PCC pavement of the same thickness. This new pavement was placed in three lanes with slabs that were 16 ft 8 in. wide and 12 ft 6 in. long. The as-built drawings show that the longitudinal joints contained dowels instead of keyed joints. The 1972 survey indicated that about 14 slabs in the center 50-ft section contained longitudinal spalls that had been patched as well as about 6 other major structural defects (see photos 3 and 4). The center section of the taxiway was in good condition, and the outer edges were in excellent condition.

18. Taxiway 21 is the taxiing area through the operational apron. Originally, the portion of the taxiway identified as feature T5A was constructed as part of the apron, and an area was marked off for taxiing purposes. It was reported that failures in the form of rutting developed in the tar concrete surface under B-52 operations, so, in 1967,

the 4-in. bituminous pavement (1-1/2-in. tar concrete and 2-1/2-in. AC) was removed and replaced with 4-in. AC. All aircraft operations from the apron area funnel onto this taxiway for alert movements or for take-offs. The surface of the taxiway pavement in 1972 showed evidence of slight rutting and longitudinal cracking from B-52 operations; however, the pavement is presently considered to be in very good condition.

19. A portion of taxiway 21 (feature T6A) crosses the area which was part of the old N-S runway. It was reported that, in two instances in the past, aircraft wheels have broken through the apron surface in areas just adjacent to the underlying old N-S runway. This portion of taxiway 21 consists of 23-in.-thick PCC and was in excellent condition.

20. The portion of taxiway 17 leading off the south edge of the operational apron through the old ADC alert apron (features T7A and T8A) consists of 23-in.-thick PCC and was rated very good during this survey. The remaining portion of taxiway 17 to the southeast end of the runway (feature T9A) consists of 21-in. reinforced PCC. There were some structural defects in this feature, such as transverse cracks, but they were held tightly together by the reinforcement. There were a number of slabs in this feature that contained corner spalls, and about half of these spalls had been patched with AC. The condition of this feature was rated as good.

Operational apron

21. The large operational apron, which is constructed of bituminous pavement (feature A2B), was in fair condition. The tar concrete surface contained some random cracking that was not associated with overloading. The tar concrete surface has received a number of slurry seal coats (coal tar pitch emulsion and sand) over the years. The most recent coat was applied in about 1967. This treatment had tended to keep surface cracks sealed. It was reported that, during hot summer days, the tar surface softens and cracking of the seal material occurs.

SAC alert facility

22. The SAC alert facility consists of a taxiway (feature T11B) and nine parking stubs (feature A5B). The taxiway was in very good condition, and the parking stubs, except stubs 6 and 9, were in

excellent condition. There were two corner breaks observed in stub 6 and four structural cracks (longitudinal, corner, and transverse) in stub 9. These two facilities were in very good condition. The alert facility is constructed mostly on a deep fill, but there was evidence of only one or two slabs near stub 2 where some slight settlement had occurred.

NW and SE warm-up aprons

23. The NW warm-up apron (feature A1B) and SE warm-up apron (feature A4B) are constructed of 19-in.-thick PCC pavement. A number of longitudinal spalls, which had been patched and are attributed to keyed joint failures, were observed on the NW warm-up apron. The SE warm-up apron did not have joint defects but did have a few structural breaks. Both apron areas were in very good condition.

Secondary facilities

24. The taxiways in the maintenance hangar areas (taxiways 7-11) were in fair to very good condition. Taxiways 8 and 9 have 50-ft-wide center sections of 23-in. PCC, and taxiways 10 and 11 are constructed of 21-in. PCC. Taxiway 10 received an AC overlay in 1966. These four taxiways (8-11) contained only a few structural defects in the taxiing areas, and the pavements were all in very good condition. Taxiway 7 was surfaced with an AC overlay over 19-in. PCC; a considerable amount of reflection cracking was evident in the overlay. However, the reflection cracks have all been sealed.

25. The 13-in. PCC in the nose dock apron areas was badly spalled, cracked, scaled, and in generally poor condition. Taxiways 22 and 27, which are ladder taxiways off the runway, are paved with AC. Both were in fair condition. There was evidence of some overload cracks, but most of the cracking in the surface was random cracking resulting from aging and climatic conditions. The pavements appeared to be performing satisfactorily.

Maintenance

26. Maintenance at EAFB had consisted of crack sealing, replacing

shattered slabs, slurry sealing, joint resealing, patching joint spalls, and repairing localized failed areas on the aprons. A copy of the annual pavement maintenance plan was obtained from the Air Force and is included in this report as Appendix A. This maintenance plan indicates the type and amount of maintenance that had been performed at EAFB through November 1969. The costs of maintenance for airfield pavements were reported to be as follows:

FY 1968 -	\$122,815
FY 1969 -	\$146,849
FY 1970 -	Not available
FY 1971 -	\$90,091
FY 1972 -	\$232,111 (to date)

27. Maintenance of the longitudinal spalls on the north end of taxiway 26 has consisted of sawing to a minimum depth of 2 in. in the sound concrete beyond the spalled area and chipping out the unsound concrete to the depth of the keyway. The exposed surface is then brushed with a tack coat, and hot-mix AC is used in the patch. When existing patches have settled 1/2 in. or more below the adjacent slab, additional hot-mix AC has been applied. These patches have been performing fairly well for the past 10 years. It was reported that, in the area of taxiway 26 that contained dowels, patching the spalls required the removal of only about 4 in. of unsound concrete (i.e., the depth of the patch was less than the depth of the dowel).

28. Maintenance of the operational apron has consisted of repairing two areas where towed aircraft were reported to have broken through the pavement surface adjacent to the old N-S runway. A slurry seal of tar emulsion and sand was placed on the apron area during about 1967, and this repair has helped to seal the cracks in the surface.

29. At the present time, there is a maintenance problem in the sod area just adjacent to the paved area where the B-52's perform engine run-up checks. The sod, along with parts of the adjacent edge of the paved surface, is being eroded away.

30. Pop-outs are not a major problem at this base, because

crushed limestone has been used as the coarse aggregate for the PCC. Some of the pop-outs have been patched with epoxy resin materials, which have performed satisfactorily.

31. The joint seal material generally was in fair condition. However, there are some areas where the joint seal material is in poor condition, and the joints need to be resealed.

Comparisons of Pavement Performances

32. The latest evaluation of the pavements was reported in June 1971 (see paragraph 6b). The thicknesses of the pavements, the physical property data, and the evaluation loads presented in the referenced report were used for a comparison of the past pavement performances with the performances indicated by the results of the condition survey reported herein.

Runway

33. Based on the evaluation loads (table 4) and present design criteria for normal operations, none of the pavements of the runway have been overloaded from B-52 operations. In consideration of the practice alert operations at 488,000-lb gross loads and under the assumption (based on the traffic data) that approximately 700 coverages of this load have been applied to the full length of the runway, the first 1,000 ft of the northwest (12) end of the runway is approaching the design criteria requirements for loads and coverages. On the basis of the 5,000 coverages applied, the southeast (30) end is in about the minimum-to-full operational category for aircraft with approximately 400,000-lb gross loads. As is noted in table 4, the evaluation gross load for this end of the runway for the minimum-to-full category is 600,000 lb.

Primary taxiways

34. Taxiway 26 in the primary taxiway system has experienced distress in the rigid and flexible pavement sections as a result of B-52 operations. These pavements were designed to support a 100,000-lb gear load on twin wheels, which at the time of construction were the loading

and gear configuration of B-47 aircraft. The flexible pavement section (feature T²A) was overlaid after distress had developed; and, with the additional overlay thickness and the present intensity of traffic, this area is not presently being overloaded by B-52 operations. The north end of taxiway 26 (feature T1A) was constructed in 1956 of 22-in.-thick PCC; shortly after B-52 operations started in about 1959, distress occurred in the longitudinal joint in the middle lane in the form of a longitudinal spall. The keyed joints on each side of the middle lane were failing. At the present time, about 96 percent of the slabs in the middle lane contain asphalt patches as a result of the keyed joint failures. This is the only type of defect noted in these slabs; thus the 22-in.-thick pavement is carrying the load of the B-52 aircraft without the benefit of a load-transfer device. The other portion of taxiway 26 (feature T⁴A), which was reconstructed by the Air Force in 1963, consists of 21-in.-thick, 50-ft-wide PCC with doweled joints. This pavement is experiencing longitudinal spalls in the 50-ft-wide reconstructed area. At the time of this survey, 68 percent of the slabs in the center 50-ft-wide section of this taxiway contained asphalt patches required because of the joint spalls.

35. Taxiway 21 through the operational apron was reconstructed of 4-in. AC in 1967, because the existing pavement (1-1/2-in. tar concrete and 2-1/2-in. AC) was rutting under B-52 operations. The replacement of the pavement surface did not change the load-carrying capability, and the AC surface is showing signs of longitudinal cracking and grooving from overloads of B-52 traffic.

36. Features T7A and T8A of taxiway 17 consist of 23-in.-thick PCC. According to the evaluation, this area is not being overloaded by present B-52 operations. The 21-in. reinforced section of taxiway 17 (feature T9A) contained some defects, but the reinforcement is keeping the cracks tightly closed. This pavement is not being overloaded by B-52 operations.

Aprons

37. All of the apron pavements (except the heavy-bomber alert apron hardstands) are overloaded by operations of the B-52 at gross

loads of approximately 400,000 lb. The large operational apron appears to be performing satisfactorily under present B-52 operations. There was little evidence of overloading in the areas where the planes are parked. Distress from overloads was, however, noted in the taxiing lanes and near the fueling pits.

Frost Action

Objectives of inspection

38. The objectives of the inspection were to determine:

- a. Any adverse effects of frost heave to the pavements during the winter months.
- b. Any traffic-induced failures that might be related to thaw weakening of the subgrades or base courses.

Frost heave of pavements

39. The airfield pavements (traffic and nontraffic areas of flexible and rigid pavements) were inspected to identify any localized or generalized surface irregularities that might indicate differential frost heaving. The inspection, which was conducted on 6 and 7 April, was believed to have coincided with or followed shortly after the period of thawing of frozen base courses and subgrades. Therefore, the effects of any detrimental nonuniform heave should have been apparent.

40. Personnel in the Base Civil Engineering Office were queried regarding the development of undesirable surface unevenness during the winter, and pilots were asked to rate the degree of roughness of the runway. Fifty-two pilots of B-52 and KC-135 aircraft were canvassed; only five rated the runway as rough, and only six considered the runway to be less smooth during the winter months. The engineers stated that the 1969 runway overlay was constructed partly to correct a rough surface. Evidently, the overlay accomplished this purpose; furthermore, frost action since that time has not caused surface irregularities to recur. The consensus of the condition survey team was that the runway did not exhibit roughness detectable in a passenger car at speeds of up to 60 mph.

41. The taxiways and aprons were not found to have suffered settlements or other vertical displacements, except for the extremely overloaded 13-in. PCC hangar access pavements and slight surface rutting in certain AC taxiways. No evidence of differential frost heave was observed, even on pavements of 20- to 25-in. combined thicknesses (pavement and base course). In fact, differential frost heave was not evident even in the old ADC alert apron, which has a 2-1/2-in. AC overlay on a 7-in. PCC pavement, for a combined thickness of 9-1/2 in. above a frost-susceptible subbase.

Thaw weakening of
subgrades or base courses

42. The extent of thaw weakening of the subgrade and base courses could not be readily determined by inspection of the pavements. Pavements usually are repaired or otherwise corrected (as with overlays) when failures occur and usually are not easily examined during a condition survey. However, even if the failed pavements can be examined, it is often impossible to determine by visual observations whether a failure is the result of thaw weakening or of deficiencies in the thickness of the subgrade, base, or pavement. In general, the depletion of the fatigue resistance of a pavement system in a frost area is progressive under repeated load applications and is inevitably related to thaw weakening, whether the evidence of fatigue or failure becomes visible during the frost-melting period or at some other time of year. Accordingly, the degree of thaw weakening and its effects, if any, on the condition of the pavements at EAFB could not be appraised merely by an inspection of the pavements. Some limited perception of the severity of frost effects at the base can be gained, however, by comparing the performance of certain pavements with what might have been expected in the light of current frost design criteria.

Pavement performances
versus frost condition criteria

43. Many of the pavements are severely deficient in slab thickness and/or in combined thickness when compared with current frost criteria or even with normal (nonfrost) design criteria. However, most

of the pavements were in good to excellent condition, and the pavements that showed distress or had been overlaid (indicating prior distress) were not necessarily those with severe thickness deficiencies. The following paragraphs contain brief comments regarding several of the pavements.

44. At the northwest end of taxiway 26 (feature T1A), nearly continuous longitudinal keyed joint failures have occurred along both edges of the center slab, thereby eliminating effective load transfer to adjoining slabs. The design is severely deficient for either frost or normal (nonfrost) design. Yet slabs in which the keyed joints have failed have not cracked further; thus it seems very doubtful that the subgrade modulus at this location has decreased during thawing seasons to the level of the magnitude assumed by current frost design criteria for the thawing season. The pavements of feature T1A, the adjoining taxiway through the northwest warm-up apron, and the northwest end of the runway (feature R3A) are of identical design and apparently experience identical traffic, yet the latter two pavements show little or no distress. A comparison of feature T1A with feature T4A (a part of the same taxiway) shows that feature T4A has a combined thickness of 62 in. and therefore must surely have a high subgrade modulus even in the spring. Yet the pavement of feature T4A shows distress only slightly less severe than feature T1A. Thus, it is believed that the pattern of distress in these pavements is not dependent on frost action, which indeed can have an insignificant effect upon them.

45. The center 50 ft of the runway interior (traffic area C) consists of 19-in. PCC over 34 in. of gravel from sta 135+30 to 155+03 (feature R7C). This structure was not considered to be deficient in design thickness for this type of facility; however, it had been overlaid with 2 in. of AC, yielding a combined thickness of 55 in. Presumably, the overlay was applied because the original pavement had manifested severe distress. The AC overlay pavement from sta 65+06 to 130+04 (feature R11C), with a combined thickness ranging from 27-1/2 to 30-1/2 in., appeared to be performing as well as the 55-in. pavement of feature R7C. The overlay was placed in 1969 and was in excellent condition at the time of this inspection. This performance is surprising, because the

combined thickness of 27-1/2 to 30-1/2 in. should be severely deficient according to current criteria (even for the normal condition) for sub-grade CBR values of 5 to 8, as are reported for EAFB in the 1971 pavement evaluation report. Possibly, the relatively good performance of the 27-1/2- to 30-1/2-in. section results from the composition of the individual layers, most of which are asphalt- or cement-stabilized materials. At any rate, the condition of the pavements in the interior of the runway suggests that they have not been significantly affected by frost action.

46. The edges of the runway have relatively thin sections (combined thickness of 20 in. from sta 40+06 to 130+04), yet roughness from frost heave was not reported nor was it observed during the inspection. Similarly, there was no evidence of differential frost heave along the edges of the taxiways, where taxiway pavements with thicknesses of 25 to 62 in. adjoin shoulder pavements with thicknesses of 17 to 20 in. Again, frost action apparently has not significantly affected the pavements.

47. The comments in paragraphs 43-46 presuppose that a significant amount of B-52 traffic has been applied at this airfield, and some of the comments would be invalid were this not so. However, the data presented in this report show that significant B-52 traffic has occurred over the years (even though the cumulative number of coverages is somewhat less than the total assumed in the design criteria) and that the coverages were applied at significantly lower loads than the 265-kip assembly load currently used for design.

Design freezing index

48. A design freezing index of 1439 degree-days has been cited in previous condition surveys and pavement evaluation reports (paragraph 6). This value is the average of the three coldest winters in the 1921 to 1954 period (1935-36, 1948-49, and 1949-50). The design freezing index reflecting the average of the three coldest years in the past 30 years (1941-1971) is 1360 degree-days. The latter determination also includes the 1948-49 and 1949-50 winters, with the winter of 1968-69 replacing 1935-36. Both design indices are based on records of the Rapid City Weather Station and consider average daily temperatures for the

transition months at both ends of the freezing seasons.

49. Seasonal indices since 1956-57 are tabulated below, together with the mean freezing index for the 1931-60 period. These values from Rapid City Weather Station records are based entirely on average monthly temperatures and are generally somewhat lower than indices that consider average daily temperatures for the transition months. On a seasonal basis, this numerical difference may vary from an essentially negligible amount to more than 150 degree-days. The values do, however, indicate the relative severity of the freezing seasons and show that several substantially colder-than-normal winters have occurred during the period of B-52 aircraft operations.

<u>Freezing Season</u>	<u>Freezing Index degree-days</u>	<u>Freezing Season</u>	<u>Freezing Index degree-days</u>
1957-58	323	1965-66	907
1958-59	794	1966-67	417
1959-60	839	1967-68	694
1960-61	363	1968-69	1230
1961-62	997	1969-70	731
1962-63	730	1970-71	1026
1963-64	578	1971-72	957
1964-65	1125	30-year Mean (1931-1960)	678

Groundwater table

50. The most logical explanation for the scant evidence of differential frost heave and of significant pavement distress during spring thaws is the existence of a very deep groundwater table. Evidence on this point is conflicting, however. Engineers attached to the Base Civil Engineering Office at EAFB expressed the opinion that at times the groundwater table is located no more than 2 to 3 ft below the ground surface. There were several references to a lake that was formerly located in the area now occupied by the runway, and it has been reported that free water was found in the base course when various pavements were excavated to install stronger inlay sections. Logs of a number of

borings taken at various locations on the base were examined. The groundwater table in most cases was not mentioned; but, in some cases, it was shown to be at depths of 20 to 30 ft. Groundwater investigations at EAFB reported by the U. S. Army Engineer District, Omaha, in April 1951, found that groundwater generally was not present within less than about 20 ft below the surface. These investigations appear to be quite conclusive. The reports that water has been found near the surface apparently refer to localized perched water, possibly from infiltration through pavement joints and cracks, and evidently such sources do not supply an ample amount of water to support extensive frost action. Possibly, this condition might be more generalized except that the landform at and surrounding the base, with well defined water courses and other topographic relief, is favorable for runoff of surface water.

Evaluation

51. The latest evaluation report for this airfield was prepared in 1971 (see paragraph 6b). The load-carrying capabilities for the various features have been taken from the 1971 report and presented in this report in table 4. This material has been repeated to provide the reader with as much of the latest pavement information as possible under one cover.

Conclusions

52. The following remarks summarize the findings of the 1972 inspection:

- a. The pavements on the northwest end of the runway are designed for 100,000-lb gear loads and are not being overloaded by present operations, since the majority of heavily loaded aircraft use the southeast end of the runway for takeoff.
- b. The keyed joint failures occurring on taxiway 26 have only recently been identified in heavy-load test sections and are failures that occur fairly rapidly. Methods of repairing or strengthening those pavements that contain

keyed joints are being investigated by the U. S. Army Engineer Waterways Experiment Station.

- c. The satisfactory performance of the 22-in. slabs after failure of the keyed joints indicates that further studies are required to determine if the present thickness requirements are too conservative.
- d. The hot-mix AC patches in the areas of longitudinal spalls on the taxiway have performed satisfactorily as a temporary form of maintenance. However, the patches settle and roughen under taxiing aircraft, and more material must be added to the patch as a filler.
- e. The recent overlay work on the runway appears to have eliminated the objectionable roughness experienced by operational personnel. However, there is still some minor roughness on the northwest end of the runway during landings.
- f. The AC overlay (4 to 6 in.) placed on taxiway 26 (feature T2A) in 1971 increased the load-carrying capability of this facility by approximately 25 percent. This overlay was placed after the most recent evaluation report was prepared.
- g. While several substantially colder-than-normal winters have been experienced in recent years at the base and the subgrade soils are classified as highly frost susceptible, it is not evident that the pavements have been adversely affected by frost heave.
- h. Features with a combined thickness of pavement and nonfrost-susceptible base that is substantially less than what is required under current design criteria have performed well. It appears that subgrades have not been severely weakened by freezing and thawing. It is believed, however, that the absence of a high groundwater table has restricted frost action.

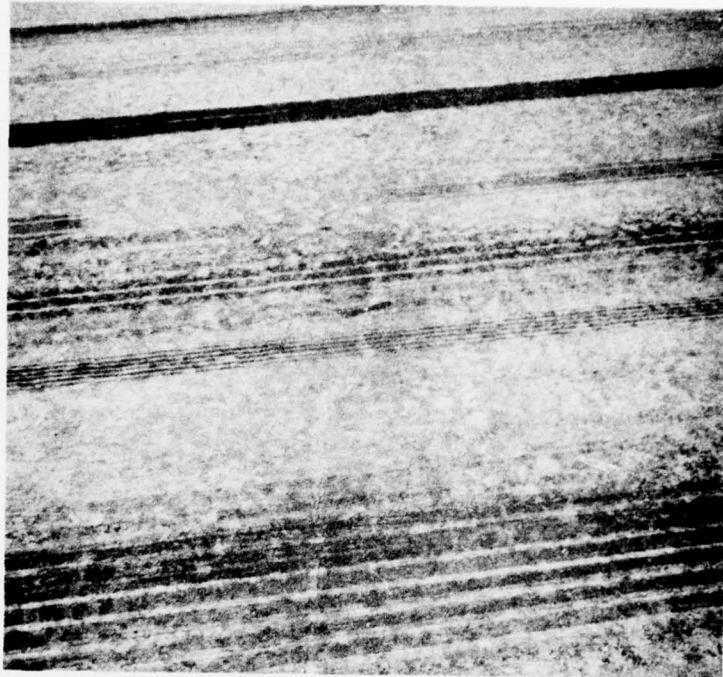


Photo 1. Transverse crack in reinforced PCC slab of NW-SE runway



Photo 2. Raveling of feathered edge of AC at sta 165+03 of NW-SE runway



Photo 3. Patched joint spalls on taxiway 26 near parking apron. Note that patches are on each side of joint

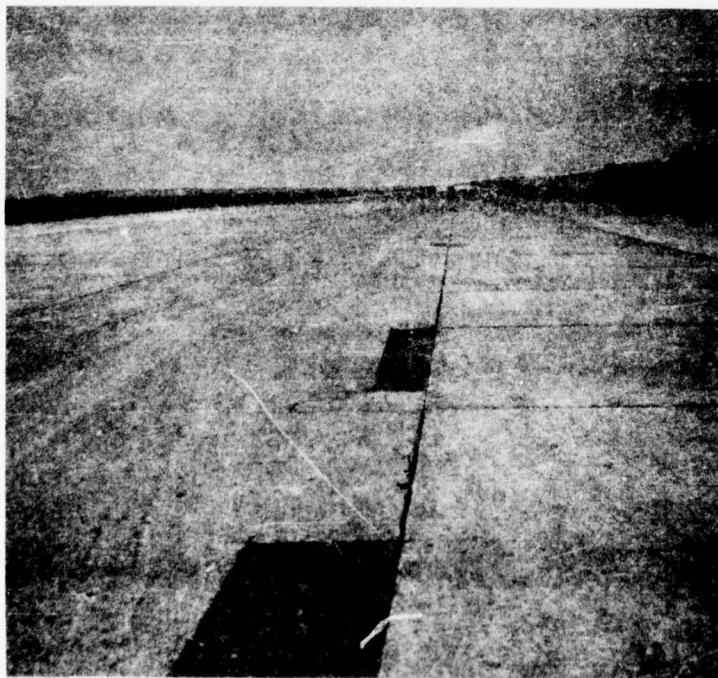


Photo 4. Patched joint spalls near north end of taxiway 26 (feature T4A)

Table 1
Airfield Construction History

Pavement Facility	Pavement Thickness in.	Type	Date(s) of Construction	Design Loading	Remarks
N-3 runway*	3-1/8 to 1-1/2	AC	1940	80,000-lb gross plane load	Abandoned
S-4 runway*	3-1/8 to 1-1/2	AC	1940	80,000-lb gross plane load	Abandoned
NW-SE runway	3-1/8 to 1-1/2	AC	1940	80,000-lb gross plane load	
Taxiways A, B, C, ** D, ** and F*	7	PCC	1940-43	70,000-lb gross plane load	Taxiways A, C, D, E, and F abandoned
Taxiway E**	7	PCC	1940	70,000-lb gross plane load	Abandoned
Taxiway G**	7	AC	1940	70,000-lb gross plane load	Abandoned
Old N-3 operational apron*	7	PCC	1940	80,000-lb gross plane load	
N-3 runway, overlay*	7	PCC	1943	80,000-lb gross plane load	
S-4 runway, overlay*	7	PCC	1943	80,000-lb gross plane load	North portion abandoned
NW-SE runway, Overlay	7	PCC	1943		
NW-SE runway					
Sta 30+00 to 47+40	3	BP	1950	80,000-lb gross plane load	
Sta 130+3 to 131+30	3	AC	1950	80,000-lb gross plane load	
Sta 130+3 to 131+30, overlay	3	AC	1950		
Taxiway K	4	BP	1950	120,000-lb gross plane load	Redesignated taxiway 17
Taxiway L	4	AC	1950	120,000-lb gross plane load	Redesignated taxiway 22
Operational apron	4	BP	1950	120,000-lb gross plane load	
Heavy maintenance apron	4	BP	1950	120,000-lb gross plane load	
Heavy-bomber hangar aprons	4	BP	1950	220,000-lb gross plane load	
Connecting taxiway	4	BP	1950	220,000-lb gross plane load	
Taxiway J	4	BP	1950	220,000-lb gross plane load	
Taxiways J-1 and J-2	4	BP	1950	120,000-lb gross plane load	
NW-SE runway, overlay	3	AC	1951	80,000-lb twin gear load	Incorporated in operational apron
N-3 runway, south end; overlay	3	AC	1951	80,000-lb twin gear load	
ADC alert taxiway and apron	3	AC	1951-52	25,000-lb single-wheel load	
ADC operational apron extension	3	AC	1951-52	25,000-lb single-wheel load	
Old N-3 operational apron, south end; overlay	3-1/2	AC	1953	25,000-lb single-wheel load	
Taxiways A and B, overlay	3-1/2	AC	1953		
Maintenance docks taxiways L-1, L-1A, L-2A, and L-3A	4	AC	1953	100,000-lb twin gear load	Redesignated taxiways 25 and 19
Multipurpose dock aprons M-1 and M-3	13	PCC	1953	25,000-lb single-wheel load	Redesignated taxiways 13, 14, 15, and 16
Taxiways M-1, M-2, and M-3	21	PCC	1953	100,000-lb twin gear load	Redesignated taxiways 26, 11, and 10
Calibration platform (overlay)*	13	PCC	1954		Abandoned
Connecting taxiway (overlay)*	5	AC	1954		Abandoned
Aircraft warehouse	17 and 18	PCC	1954	80,000- and 25,000-lb gear load	
Maintenance aprons M-4 and M-5	17	PCC	1955	80,000-lb gear load	
Taxiways M-1, M-4, and M-5	4	AC	1955	100,000-lb gear load	
NW-SE runway extension	28-19 and 17	PCC	1955	100,000-lb twin gear load	Redesignated taxiways 26, 9, and 8
Primary taxiway	19 and 22	PCC	1956	100,000-lb twin gear load	Taxiway 26
N and S warm-up aprons	19	PCC	1956	100,000-lb twin gear load	
Maintenance aprons M-6 and M-5 (extension)	19	PCC	1956	80,000-lb gear load	
Taxiways M-6 and M-5 (extension)	19	PCC	1956	100,000-lb twin gear load	Taxiways 7 and 8
Maintenance dock aprons L-1A, L-2A, and L-3A	19	PCC	1956	80,000-lb gear load	
Taxiways L-1A, L-2A, and L-3A	19	PCC	1956	100,000-lb twin gear load	Redesignated aprons
Heavy-bomber hangar apron extension	19	PCC	1958	160,000-lb twin-twin gear load	
Heavy-bomber alert apron	22	PCC	1958	225,000-lb twin-twin gear load	
Heavy-bomber alert taxiway	22	PCC	1958	225,000-lb twin-twin gear load	
NW-SE runway reconstruction, sta 30+00 to 40+00	22 and 23	PCC	1958	225,000-lb twin-twin gear load	
Through taxiway on operational apron and parking apron	22 and 23	PCC	1958	225,000-lb twin-twin gear load	
Taxiway M-4 and M-5	23	PCC	1959		
NW-SE runway, sta 40+00 to 45+00	18	PCC†	1960	225,000-lb twin-twin gear load	Air Force replaced 50 ft of flexible pavement with two 25-in. lanes of rigid pavement, taxiways 9 and 8
NW-SE runway (overlay), sta 45+00 to 130+00	2 to 5	AC	1960		Center 75 ft
NW-SE runway, sta 130+04 to 135+10	17	PCC†	1960	225,000-lb twin-twin gear load	Center 75 ft
Taxiway K	21	PCC†	1961	225,000-lb twin-twin gear load	Replaced center 50 ft, taxiway 17
Taxiway M-2 apron access	21	PCC	1963		Air Force replaced two lanes, 50 ft wide, taxiway 11
NW-SE runway extension Inlay, sta 0+00 to 10+00	19	PCC	1963		Air Force replaced two 50-ft-wide center lanes, edges thickened to 24 in.
Taxiway M-1 adjoining taxiways M-2 and M-3	21	PCC	1963		Air Force replaced three 50-ft-wide lanes, taxiway 26
Missile loading/unloading facility and taxiway F3	3	AC	1965		
Pad	17	PCC	1965		
Hangar access apron off taxiway 14	4	AC	1966		
Taxiway 10 (overlay)	2	AC	1966		
NW-SE runway (overlay), sta 135+00 to 160+00	2	AC	1966		
NW-SE runway (overlay), sta 05+00 to 135+00	1-1/2	AC	1969		
Taxiway 26 (old taxiway M-1) center 50 ft	4 to 6	AC	1971		

* Portion of abandoned or partly abandoned pavement that is shown in plate 1.

** Abandoned pavement that is not shown in plate 1.

† Bituminous pavement.

†† Reinforced.

Table 2
SUMMARY OF DYNAMIC DOCUMENT DATA

Table 2 (Continued)
SUMMARY OF PHYSICAL PROPERTY DATA

FACILITY NUMBER AND IDENTIFICATION	LENGTH FT	OVERLAY PAVEMENT		PAVEMENT			BASE		SUB-SURFACE		GENERAL CONDITION OF AREA OR CONSIDERED
		THICK. IN.	DESCRIPTION	THICK. IN.	DESCRIPTION	THICK. IN.	CLASSIFICATION	CBR OR K	CLASSIFICATION	CBR OR K	
701D Main run; center, sta 130+30 to 130+33	1973	195	2 Asphaltic concrete	17	Portland cement concrete	650	4 Gravel filter course (75)	K = 60 K _f = 25	Clay (CH or CL)	Front Op F-3	Excellent
701C Main run; 90-ft center, sta 130+30 to 130+33	1973	50	2 Asphaltic concrete	39	Portland cement concrete	650	24 Gravel limestone (75)	K = 60 K _f = 25	Clay (CH or CL)	Front Op F-3	Excellent
701G Main run; 90-ft 75-ft center, sta 130+66 to 130+69	274	75		38 Reinforced Portland cement concrete	750	10 Gravel filter course (75)	K = 25 K _f = 25	Front Op F-3	Clay (CH or CL)	Front Op F-3	Good
701D Main run; 90-ft end; 30-ft edges, sta 130+5 to 130+60	256	112.5		3 Asphaltic concrete	650	12 Gravel limestone (75)	K = 70 K _f = 25	Clay (CH or CL)	Front Op F-3	Front Op F-3	Good
701B Main run; 90-ft end; 100-ft center, sta 35+65 to 40+66	500	100		22 Portland cement concrete	665	15 Gravel subbase (75)	K = 80 K _f = 25	Clay (CH or CL)	Front Op F-3	Front Op F-3	Excellent
701D Main run; 90-ft end; 30-ft edges, sta 35+65 to 40+66	500	100		15 Portland cement concrete	665	25 Gravel base (75)	K = 140 K _f = 140	Clay (CH or CL)	Front Op F-3	Front Op F-3	Excellent
701A Main run; 90-ft end; 30-ft edges, sta 35+65 to 40+66	500	30		23 Portland cement concrete	665	32 Gravel base (75)	K = 160 K _f = 140	Clay (CH or CL)	Front Op F-3	Front Op F-3	Excellent
701A Main run; 90-ft end; 30-ft edges, sta 35+65 to 40+66	3330	50 to 75		19-39 Portland cement concrete	650	28 Gravel base (75)	K = 140 K _f = 140	Clay (CH or CL)	Front Op F-3	Front Op F-3	Excellent
701A Towing 26	2450	50 to 60	Asphaltic concrete	6 Asphaltic concrete	650	4 Gravel filter course (75)	K = 80 K _f = 25	Clay (CH or CL)	Front Op F-3	Front Op F-3	Fair
712A Center 50 ft of towing 26 and 27	783	75	2 Asphaltic concrete	19 Portland cement concrete	680	4 Gravel filter course (75)	K = 60 K _f = 25	Clay (CH or CL)	Front Op F-3	Front Op F-3	Fair
712B Towing 7	1300	50		22-32 Portland cement concrete	700	20 Gravel base course (75)	K = 120 K _f = 120	Clay (CH or CL)	Front Op F-3	Front Op F-3	Very Good

Table 2 (continued)
SUMMARY OF PHYSICAL PROPERTY DATA

FACILITY NUMBER AND IDENTIFICATION	OVERLAY PAVEMENT				PAVEMENT				BASE		SUBGRADE		GENERAL CONDITION OF AREA CONSIDERED K	
	LENGTH FT	WIDTH FT	THICK. IN	DESCRIPTION	FLEX. STR. PSI	THICK. IN	DESCRIPTION	FLEX. STR. PSI	THICK. IN	CLASSIFICATION	CBR ON K	CLASSIFICATION	CBR ON K	
T2B Outside 25 ft. of Taxway 3	1300	25												Good
TIBB 50-ft. heel in Taxway 9	1650	50												Very good
TIBB Outside 25 ft. of Taxway 9	1650	25												Good
TIBB 50-ft. heel in Taxway 9	1650	50												Good
TIBB Outside 25 ft. of Taxway 10	300	75												Good
TIBB Taxway off Taxway 10	2000	75	2	Asphaltic concrete										Fair
TIBB 50-ft. heel section in Taxway 11	1975	50												Very good
TIBB Outside 25 ft. of Taxway 11	1975	25												Very good
TIBB Taxway to subtrack	250	75												Fair
TIBB Ladder Taxways off Taxway 11	Varied	Varied												Good
TIA Taxway 26	1325	75												Good
TIBB Taxway 21	4200	50												Very good

Table 2 (Continued)
SUMMARY OF PHYSICAL PROPERTY DATA

FACILITY NUMBER AND IDENTIFICATION	OVERLAY PAVEMENT			PAVEMENT			BASE			SUBGRADE		GENERAL CONDITION OF AREA CONSIDERED
	LENGTH FT	WIDTH FT	THICK. IN.	DESCRIPTION	THICK. IN.	DESCRIPTION	THICK. IN.	CLASSIFICATION	CBR OR K	CLASSIFICATION	CBR OR K	
728 Pavement 66 and 20', outside edge	2650	15', 27', 30'			4	Asphaltic concrete		6	Crushed limestone (60)	K = 60 Front Op. P-2	CBR = 6 Front Op. P-3	Fair
729 Pavement 21 (through oil +2' roadway)	448	100		22'- 23'- 22'	Portland cement concrete		6.6	Sand subbase (36)	K = 60 Front Op. P-2	CBR = 6 Front Op. P-3	Excellent	
730 Pavement 27 (through oil ADC alert apron)	89	75		23	Portland cement concrete		24	Gravel base (36)	K = 60 Front Op. P-2	CBR = 6 Front Op. P-3	Very good	
731 Pavement 17 (through oil ADC alert apron)	597	75		22'- 23'- 22'	Portland cement concrete		25	Gravel base (36)	K = 60 Front Op. P-2	CBR = 6 Front Op. P-3	Very good	
732 Center 50 ft. of roadway 17	1810	50		21	Reinforced Portland cement concrete		7.50	Gravel base (36)	K = 60 Front Op. P-2	CBR = 6 Front Op. P-3	Good	
733 Outside edge of roadway 17	1210	Varies		4	Asphaltic concrete		12	Crushed limestone (36)	K = 60 Front Op. P-2	CBR = 6 Front Op. P-3	Good	
734 Center 25 ft. of ADC alert apron and roadway	2897	25		22	Portland cement concrete		25	Gravel subbase (36), P-2	K = 60 Front Op. P-2	CBR = 6 Front Op. P-3	Very good	
735 Pavement 22	890	100		4	Asphaltic concrete		12	Crushed limestone (36), P-2	K = 60 Front Op. P-2	CBR = 6 Front Op. P-3	Good	
736 Center 150 ft. of roadway 25	1100	150	5	Asphaltic concrete	7	Portland cement concrete	6.50	3-1/2' asphaltic concrete	K = 200 Front Op. P-3	CBR = 6 Front Op. P-3	Good	
737 Outside edge of roadway 25	1100	75	4	Asphaltic concrete	7	Portland cement concrete	6.50	1-1/2' asphaltic concrete	K = 200 Front Op. P-3	CBR = 6 Front Op. P-3	Fair	
738 Center 25 ft. of roadway 13, 14, 15, and 16	678.5	25			4	Asphaltic concrete	6	Gravel (36)	K = 60 Front Op. P-2	CBR = 6 Front Op. P-3	Good	
							12	Crushed limestone (36)	K = 60 Front Op. P-2	CBR = 6 Front Op. P-3		
							25	Gravel subbase (36)	K = 60 Front Op. P-2	CBR = 6 Front Op. P-3		

Table 2 (continued)
SUMMARY OF PHYSICAL PROPERTY DATA

FACILITY NUMBER AND IDENTIFICATION	OVERLAY/PAVEMENT				PAVEMENT				BASE		SUBGRADE	
	LENGTH FT	WIDTH FT	THICK. IN.	DESCRIPTION	THICK. IN.	DESCRIPTION	THICK. IN.	CLASSIFICATION	CBR K	CLASSIFICATION	CBR K	GENERAL CONDITION OF AREA CONSIDERED
721B Threading 23	775	75			3	Asphaltic concrete	6	Crushed limestone Gravel substrate	CBR K = 80	Clay (D1 or C1)	CBR K = 5	Excellent
721B Threading 5	572	75			8	Asphaltic concrete	4	Gravel filter course	CBR K = 80	Clay (D1 or C1)	CBR K = 5	Good
721B Apron with roadway 7	522	287.5	2	Asphaltic concrete	19	Portland cement concrete	15	Crushed limestone Gravel substrate	CBR K = 80	Clay (D1 or C1)	CBR K = 5	Good
721B Apron with roadway 8	1000	287.5			17	Portland cement concrete	10	Gravel filter course	CBR K = 80	Clay (D1 or C1)	CBR K = 5	Good
721B North end of Apron with roadway 8	236	300			19	Portland cement concrete	650	Gravel filter course (50%)	CBR K = 80	Clay (D1 or C1)	CBR K = 5	Good
721B Apron with roadway 9	1360	462			17	Portland cement concrete	650	Gravel filter course (50%)	CBR K = 80	Clay (D1 or C1)	CBR K = 5	Good
721B Apron with roadway 10	Varies	Varies			13	Portland cement concrete	650	Gravel filter course (50%)	CBR K = 80	Clay (D1 or C1)	CBR K = 5	Poor
721B Waterstop	Varies	Varies			12	Portland cement concrete	620	Gravel filter course (50%)	CBR K = 80	Clay (D1 or C1)	CBR K = 5	Poor
721B Apron with roadway 11	Varies	Varies			13	Portland cement concrete	620	Gravel filter course (50%)	CBR K = 80	Clay (D1 or C1)	CBR K = 5	Poor
721B Operational Apron	Varies	860			14	Tar concrete	12	Crushed limestone (50%), F-1 Gravel substrate (50%), F-1	CBR K = 80	Clay (D1 or C1)	CBR K = 6	Poor
721B Old ADG absent Apron	Varies	660	2-1/2	Asphaltic concrete	8	Portland cement concrete	650		CBR K = 80	Clay (D1 or C1)	CBR K = 5	Poor
									CBR K = 80	Front GP F-3	CBR K = 5	
									CBR K = 80	Clay (D1 or C1)	CBR K = 5	
									CBR K = 80	Front GP F-3	CBR K = 5	

Table 2 (Continued)
SUMMARY OF PHYSICAL PROPERTY DATA

FACILITY NUMBER AND IDENTIFICATION	OVERLAY PAVEMENT			PAVEMENT			BASE			SUBGRADE		
	LENGTH FT	THICK. IN	DESCRIPTION	FLEX. STR. PSI	THICK. IN.	DESCRIPTION	FLEX. STR. PSI	THICK. IN.	CLASSIFICATION	CBR OR K	CLASSIFICATION	CBR OR K
A13B Bunker access sprays 13, 14, and 15	308.5	140			19	Portland cement concrete	650	4	gravel filter course ($\frac{1}{2}$ in.)	K = 60	Clay (CH or CL)	Very good
A13B Apron access to docks 13, 14, 15, and 16, outside	697.5	Varies			4	Asphaltic concrete		42	Crushed limestone ($\frac{1}{2}$ in.)	Kf = 25	Frost Op F-3	
A13B Old Hwy used as part of parking apron (center 150 ft)	1000+	150			7	Portland cement concrete	750	29	Gravel subbase ($\frac{1}{2}$ in.)	Kf = 65	Clay (CH or CL)	Fair CBR = 5
A13B Old Hwy used as part of parking apron (outside 75 ft)	1200+	75			7	Portland cement concrete	750	1-1/2	Asphaltic concrete ($\frac{1}{2}$ in.)	K = 75	Frost Op F-3	
A13B South apron	753	394			19	Portland cement concrete	650	6	Gravel base ($\frac{1}{2}$ in.)	Kf = 50	Clay (CH or CL)	Good
A13B ADC alert apron	310	150			3	Asphaltic concrete		6	Gravel filter course ($\frac{1}{2}$ in.)	Kf = 60	Clay (CH or CL)	Good
A13B SAC alert apron	2897	Varies			22	Portland cement concrete	655	15	Gravel subbase (F-1)	Kf = 50	Frost Op F-3	
A13B Loading pad, center portion					17	Portland cement concrete	670	24	Gravel base ($\frac{1}{2}$ in.)	K = 120	Clay (CH or CL)	Excellent
A13B Loading pad, exterior portion		25						13	Crushed limestone ($\frac{1}{2}$ in.)	Kf = 120	Frost Op F-3	
A13B Old warm-up apron		Varies						4	filter course	Kf = 120	Clay (CH or CL)	Excellent
A13B Wk warm-up apron	790	225						6	crushed limestone ($\frac{1}{2}$ in.)	Kf = 80	Clay (CH or CL)	CBR = 5
								10	subbase ($\frac{1}{2}$ in.)	K = 50	Frost Op F-3	
								4	sand filter course	K = 140	Clay (CH or CL)	Very good
								4	gravel filter course ($\frac{1}{2}$ in.)	Kf = 120	Frost Op F-3	
								4	gravel filter course ($\frac{1}{2}$ in.)	Kf = 25	Clay (CH or CL)	Very good

Table 3

DATE: April 1, 1970	SUMMARY OF DATA - RIGID PAVEMENT CONDITION SURVEY														AIRFIELD				
	FEATURE No. & Description	SLAB SIZE FT	APPROX NO OF SLABS	PAVE THICK IN	NO OF SLABS CONTAINING INDICATED DEFECTS										% OF SLABS NO DEFECTS	% OF SLABS NO MAJOR DEFECTS	CONDITION		
					I	-	\	△	*	~~	S	J	U	J	C	M	K	O	
11158 11151 - 11154 11156	MacMillan runway, 30' x 50' x 6' 11151 - 11154 11156	240	375	3						3						13	100.0	99.0	Excellent
11175 11171 - 11174 11176	MacMillan runway, 30' x 50' x 6' 11171 - 11174 11176	240	375	1						1						1	100.0	99.0	Excellent
11176 11175 - 11178 11179	MacMillan runway, 30' x 50' x 6' 11175 - 11178 11179	240	375	1						1						1	100.0	99.0	Good
11179 11176 - 11179 11180	MacMillan runway, 30' x 50' x 6' 11176 - 11179 11180	240	375	1						1						1	100.0	100.0	Excellent
11180 11177 - 11180 11183	MacMillan runway, 30' x 50' x 6' 11177 - 11180 11183	240	375	1						1						1	100.0	100.0	Excellent
11183 11180 - 11183 11185	MacMillan runway, 30' x 50' x 6' 11180 - 11183 11185	240	375	1						1						1	100.0	99.0	Excellent
11185 11182 - 11185 11188	MacMillan runway, 30' x 50' x 6' 11182 - 11185 11188	240	375	1						1						1	100.0	99.0	Excellent
11188 11185 - 11188 11191	MacMillan runway, 30' x 50' x 6' 11185 - 11188 11191	240	375	1						1						1	100.0	99.0	Excellent
11191 11188 - 11191 11194	MacMillan runway, 30' x 50' x 6' 11188 - 11191 11194	240	375	1						1						1	100.0	99.0	Excellent
11194 11191 - 11194 11197	MacMillan runway, 30' x 50' x 6' 11191 - 11194 11197	240	375	1						1						1	100.0	99.0	Excellent
11197 11194 - 11197 11200	MacMillan runway, 30' x 50' x 6' 11194 - 11197 11200	240	375	1						1						1	100.0	99.0	Excellent
11200 11197 - 11200 11203	MacMillan runway, 30' x 50' x 6' 11197 - 11200 11203	240	375	1						1						1	100.0	99.0	Excellent
11203 11198 - 11203 11206	MacMillan runway, 30' x 50' x 6' 11198 - 11203 11206	240	375	1						1						1	100.0	99.0	Excellent
11206 11199 - 11206 11209	MacMillan runway, 30' x 50' x 6' 11199 - 11206 11209	240	375	1						1						1	100.0	99.0	Excellent
11209 11206 - 11209 11212	MacMillan runway, 30' x 50' x 6' 11206 - 11209 11212	240	375	1						1						1	100.0	99.0	Excellent
11212 11209 - 11212 11215	MacMillan runway, 30' x 50' x 6' 11209 - 11212 11215	240	375	1						1						1	100.0	99.0	Excellent
11215 11212 - 11215 11218	MacMillan runway, 30' x 50' x 6' 11212 - 11215 11218	240	375	1						1						1	100.0	99.0	Excellent
11218 11215 - 11218 11221	MacMillan runway, 30' x 50' x 6' 11215 - 11218 11221	240	375	1						1						1	100.0	99.0	Excellent
11221 11218 - 11221 11224	MacMillan runway, 30' x 50' x 6' 11218 - 11221 11224	240	375	1						1						1	100.0	99.0	Excellent
11224 11221 - 11224 11227	MacMillan runway, 30' x 50' x 6' 11221 - 11224 11227	240	375	1						1						1	100.0	99.0	Excellent
11227 11224 - 11227 11230	MacMillan runway, 30' x 50' x 6' 11224 - 11227 11230	240	375	1						1						1	100.0	99.0	Excellent
11230 11227 - 11230 11233	MacMillan runway, 30' x 50' x 6' 11227 - 11230 11233	240	375	1						1						1	100.0	99.0	Excellent
11233 11230 - 11233 11236	MacMillan runway, 30' x 50' x 6' 11230 - 11233 11236	240	375	1						1						1	100.0	99.0	Excellent
11236 11233 - 11236 11239	MacMillan runway, 30' x 50' x 6' 11233 - 11236 11239	240	375	1						1						1	100.0	99.0	Excellent
11239 11236 - 11239 11242	MacMillan runway, 30' x 50' x 6' 11236 - 11239 11242	240	375	1						1						1	100.0	99.0	Excellent
11242 11239 - 11242 11245	MacMillan runway, 30' x 50' x 6' 11239 - 11242 11245	240	375	1						1						1	100.0	99.0	Excellent
11245 11242 - 11245 11248	MacMillan runway, 30' x 50' x 6' 11242 - 11245 11248	240	375	1						1						1	100.0	99.0	Excellent
11248 11245 - 11248 11251	MacMillan runway, 30' x 50' x 6' 11245 - 11248 11251	240	375	1						1						1	100.0	99.0	Excellent
11251 11248 - 11251 11254	MacMillan runway, 30' x 50' x 6' 11248 - 11251 11254	240	375	1						1						1	100.0	99.0	Excellent
11254 11251 - 11254 11257	MacMillan runway, 30' x 50' x 6' 11251 - 11254 11257	240	375	1						1						1	100.0	99.0	Excellent
11257 11254 - 11257 11260	MacMillan runway, 30' x 50' x 6' 11254 - 11257 11260	240	375	1						1						1	100.0	99.0	Excellent
11260 11257 - 11260 11263	MacMillan runway, 30' x 50' x 6' 11257 - 11260 11263	240	375	1						1						1	100.0	99.0	Excellent
11263 11260 - 11263 11266	MacMillan runway, 30' x 50' x 6' 11260 - 11263 11266	240	375	1						1						1	100.0	99.0	Excellent
11266 11263 - 11266 11269	MacMillan runway, 30' x 50' x 6' 11263 - 11266 11269	240	375	1						1						1	100.0	99.0	Excellent
11269 11266 - 11269 11272	MacMillan runway, 30' x 50' x 6' 11266 - 11269 11272	240	375	1						1						1	100.0	99.0	Excellent
11272 11269 - 11272 11275	MacMillan runway, 30' x 50' x 6' 11269 - 11272 11275	240	375	1						1						1	100.0	99.0	Excellent
11275 11272 - 11275 11278	MacMillan runway, 30' x 50' x 6' 11272 - 11275 11278	240	375	1						1						1	100.0	99.0	Excellent
11278 11275 - 11278 11281	MacMillan runway, 30' x 50' x 6' 11275 - 11278 11281	240	375	1						1						1	100.0	99.0	Excellent
11281 11278 - 11281 11284	MacMillan runway, 30' x 50' x 6' 11278 - 11281 11284	240	375	1						1						1	100.0	99.0	Excellent
11284 11281 - 11284 11287	MacMillan runway, 30' x 50' x 6' 11281 - 11284 11287	240	375	1						1						1	100.0	99.0	Excellent
11287 11284 - 11287 11290	MacMillan runway, 30' x 50' x 6' 11284 - 11287 11290	240	375	1						1						1	100.0	99.0	Excellent
11290 11287 - 11290 11293	MacMillan runway, 30' x 50' x 6' 11287 - 11290 11293	240	375	1						1						1	100.0	99.0	Excellent
11293 11290 - 11293 11296	MacMillan runway, 30' x 50' x 6' 11290 - 11293 11296	240	375	1						1						1	100.0	99.0	Excellent
11296 11293 - 11296 11299	MacMillan runway, 30' x 50' x 6' 11293 - 11296 11299	240	375	1						1						1	100.0	99.0	Excellent
11299 11296 - 11299 11302	MacMillan runway, 30' x 50' x 6' 11296 - 11299 11302	240	375	1						1						1	100.0	99.0	Excellent
11302 11299 - 11302 11305	MacMillan runway, 30' x 50' x 6' 11299 - 11302 11305	240	375	1						1						1	100.0	99.0	Excellent
11305 11302 - 11305 11308	MacMillan runway, 30' x 50' x 6' 11302 - 11305 11308	240	375	1						1						1	100.0	99.0	Excellent
11308 11305 - 11308 11311	MacMillan runway, 30' x 50' x 6' 11305 - 11308 11311	240	375	1						1						1	100.0	99.0	Excellent
11311 11308 - 11311 11314	MacMillan runway, 30' x 50' x 6' 11308 - 11311 11314	240	375	1						1						1	100.0	99.0	Excellent
11314 11311 - 11314 11317	MacMillan runway, 30' x 50' x 6' 11311 - 11314 11317	240	375	1						1						1	100.0	99.0	Excellent
11317 11314 - 11317 11320	MacMillan runway, 30' x 50' x 6' 11314 - 11317 11320	240	375	1						1						1	100.0	99.0	Excellent
11320 11317 - 11320 11323	MacMillan runway, 30' x 50' x 6' 11317 - 11320 11323	240	375	1						1						1	100.0	99.0	Excellent
11323 11320 - 11323 11326	MacMillan runway, 30' x 50' x 6' 11320 - 11323 11326	240	375	1						1						1	100.0	99.0	Excellent
11326 11323 - 11326 11329	MacMillan runway, 30' x 50' x 6' 11323 - 11326 11329	240	375	1						1						1	100.0	99.0	Excellent
11329 11326 - 11329 11332	MacMillan runway, 30' x 50' x 6' 11326 - 11329 11332	240	375	1						1						1	100.0	99.0	Excellent
11332 11329 - 11332 11335	MacMillan runway, 30' x 50' x 6' 11329 - 11332 11335	240	375	1						1						1	100.0	99.0	Excellent
11335 11332 - 11335 11338	MacMillan runway, 30' x 50' x 6' 11332 - 11335 11338	240	375	1						1						1	100.0	99.0	Excellent
11338 11335 - 11338 11341	MacMillan runway, 30' x 50' x 6' 11335 - 11338 11341	240</																	

DATE:

SUMMARY OF DATA - RIGID PAVEMENT CONDITION SURVEY

DATE:	SUMMARY OF DATA - RIGID PAVEMENT CONDITION SURVEY																	
	FEATURE		SLAB SIZE FT	APPROX NO. OF SLABS	PAVE THICK IN	NO. OF SLABS		CONTAINING INDICATED DEFECTS										
	% GOOD	% DEFECTIVE				1	-	\	Δ	*	~	S	J	T	C	M	K	O
T111B	140' alert	45	100x15	500	3/8	20	2					7	1	10	18	94.3	97.2	Very Good
T111B	140' alert	55	100x15	500	3/8	20	2					15	10	25	10	93.5	97.5	Excellent
A103B	140' alert	45	75x25	600	3/8	1	2	1	5							93.5	97.5	Very Good
A103B	140' alert	55	75x25	600	3/8	1	2	1	5							93.5	97.5	Very Good
A111B	156' smooth-up	45	75x25	231	15	2									93.5	97.5	Very Good	
A111B	156' smooth-up	55	75x25	231	15	2									93.5	97.5	Very Good	
A111B	156' smooth-up	45	75x25	139	15	1	1	1	2						93.5	97.5	Very Good	
A111B	156' smooth-up	55	75x25	139	15	1	1	1	2						93.5	97.5	Very Good	
T111B	70x160' 111	45	100x15	300	3/8	3	4	5	7			25	14	31	4	91.7	97.5	Very Good
T111B	70x160' 111	55	100x15	300	3/8	3	4	5	7			25	14	31	4	91.7	97.5	Very Good

REMARKS: 5 - This feature has 14 joint stalls that have been patched (possibly 10 of these could be beyond failure).
- Most of stalls have light on cracked.

LEGEND:

The diagram illustrates five types of rock fractures:

- LONGITUDINAL CRACK: A vertical line with a single horizontal break.
- TRANSVERSE CRACK: A horizontal line with a single vertical break.
- DIAGONAL CRACK: A line sloping upwards to the right, with a single break.
- CORNER BREAK: A line with a 90-degree turn, with a break on both segments.
- SHATTERED SLAB: A line with multiple irregular breaks.

~~~	SHRINKAGE	CRACK
S	SCALING	
J	SPALL ON TRANSVERSE	
J	SPALL ON LONGITUDINAL	
J	CORNER SPALL	

**UNCONTROLLED CONTRACTION CRACK**  
**C** **M** **K** **O**  
**MAP CRACKING**  
**KEYWAY JOINT**  
**FAILURE**  
**POP-OUT**

Table 4  
SUMMARY OF PAVEMENT EVALUATION

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DITION OF AUG 1960 IS OBSOLETE.

(1 of 5 sheets)

Table 4 (continued)  
SUMMARY OF PAVEMENT EVALUATION

NAME OF AIRFIELD Ellsworth AFB, S. Dak		LOAD-CARRYING CAPACITY IN LB OF GROSS PLANE LOAD FOR INDICATED LANDING GEAR TYPES AND CONFIGURATIONS											
DATE OF EVALUATION MONTH APRIL YR 1972		TRICYCLE ARRANGEMENT											
FEATURE	PAVEMENT OPERATIONAL USE	SINGLE TIRE PRESSURE	SINGLE 100-SQ-IN CONTACT AREA	SINGLE 147-SQ-IN CONTACT AREA	SINGLE 206-SQ-IN CONTACT AREA	SINGLE 247-SQ-IN CONTACT AREA	TWIN TIRE 206-SQ-IN CONTACT AREA	TWIN TIRE 247-SQ-IN CONTACT AREA	TWIN TIRE 311-SQ-IN CONTACT AREA	TWIN TIRE 406-SQ-IN CONTACT AREA	BICYCLE	TAN TAN SPEC 37-2-37 NOT IN CONTACT AREA EACH TIRE	
NO.	DESIGNATION	1	2	3	4	5	6	7	8	9	10	REMARKS	
RL7B	Runway, as em; 110-ft center, ts 3546 to 4046	Capacity 105,000+ Frost capacity 105,000+	85,000+ 85,000+	105,000+ 105,000+	220,000+ 220,000+	200,000+ 200,000+	330,000+ 330,000+	230,000+ 230,000+	330,000+ 330,000+	330,000+ 330,000+	330,000+ 330,000+	400,000+ 400,000+	
EL7A	Runway, as em; 3546 to 3546	Capacity 105,000+ Frost capacity 105,000+	85,000+ 85,000+	105,000+ 105,000+	220,000+ 220,000+	200,000+ 200,000+	330,000+ 330,000+	230,000+ 230,000+	330,000+ 330,000+	330,000+ 330,000+	330,000+ 330,000+	400,000+ 400,000+	
TL7A	Taxiway 26	Capacity 105,000+ Frost capacity 105,000+	85,000+ 85,000+	105,000+ 105,000	211,000 190,000	200,000+ 200,000+	195,000 170,000	230,000+ 210,000	300,000 245,000	300,000 245,000	300,000 245,000	375,000 235,000	Reduced 25% due to pavement condition
TL7A	Center 50 ft of taxiways 26 and 27	Capacity 105,000+ Frost capacity 30,000	85,000+ 30,000	105,000+ (a)	220,000+ (a)	200,000+ (a)	330,000+ (a)	230,000+ (a)	330,000+ (a)	330,000+ (a)	330,000+ (a)	550,000 (a)	
TL2B	Taxiway 7	Capacity 105,000+ Frost capacity 105,000+	85,000+ 85,000+	105,000+ 105,000+	220,000+ 220,000+	200,000+ 200,000+	300,000 300,000	230,000+ 230,000+	330,000+ 330,000+	330,000+ 330,000+	330,000+ 330,000+	380,000+ 370,000	
TL3B	50-ft heel in taxiway 8	Capacity 105,000+ Frost capacity 105,000+	85,000+ 85,000+	105,000+ 105,000+	220,000+ 220,000+	200,000+ 200,000+	330,000+ 330,000+	230,000+ 230,000+	330,000+ 330,000+	330,000+ 330,000+	330,000+ 330,000+	380,000+ 370,000	
TL4B	50-ft heel in taxiway 9	Capacity 105,000+ Frost capacity 105,000+	85,000+ 85,000+	105,000+ 105,000+	220,000+ 220,000+	200,000+ 200,000+	330,000+ 330,000+	230,000+ 230,000+	330,000+ 330,000+	330,000+ 330,000+	330,000+ 330,000+	380,000+ 370,000	
TL5B	Outer taxiway off taxiway 10	Capacity 105,000+ Frost capacity 105,000+	85,000+ 85,000+	105,000+ 105,000+	220,000+ 220,000+	200,000+ 200,000+	300,000 280,000	230,000+ 230,000+	330,000+ 330,000+	330,000+ 330,000+	330,000+ 330,000+	380,000+ 370,000	
TL6B	Taxiway 10	Capacity 105,000+ Frost capacity 85,000+	85,000+ 85,000+	105,000+ 105,000+	220,000+ 220,000+	200,000+ 200,000+	330,000+ 330,000+	230,000+ 230,000+	330,000+ 330,000+	330,000+ 330,000+	330,000+ 330,000+	430,000	
TL7B	50-ft heel in taxiway 11	Capacity 105,000+ Frost capacity 105,000+	85,000+ 85,000+	105,000+ 105,000+	220,000+ 220,000+	200,000+ 200,000+	330,000+ 330,000+	230,000+ 230,000+	330,000+ 330,000+	330,000+ 330,000+	330,000+ 330,000+	390,000	
TL7B	Taxiway to washrack	Capacity 130,000 Frost capacity 130,000	85,000+ 85,000+	105,000+ 105,000+	210,000 220,000+	200,000+ 200,000+	235,000 230,000+	230,000+ 230,000+	330,000+ 330,000+	330,000+ 330,000+	330,000+ 330,000+	460,000	
TL6B	Outer taxiways off taxiway 11	Capacity 105,000+ Frost capacity 105,000+	85,000+ 85,000+	105,000+ 105,000+	220,000+ 220,000+	200,000+ 200,000+	300,000 260,000	230,000+ 230,000+	330,000+ 330,000+	330,000+ 330,000+	330,000+ 330,000+	380,000 350,000	

REF ID: A12162 IS DRAFT

EDITION OF AUS 1960 IS DRAFT

(p. of 5 sheets)

Table 4 (continued)  
SUMMARY OF PAVEMENT EVALUATION

LOAD-CARRYING CAPACITY IN LB OF GROSS PLANE LOAD FOR INDICATED LANDING GEAR TYPES AND CONFIGURATIONS										
TRICYCLE ARRANGEMENT										
NAME OF AIRFIELD S. Dak. DATE OF EVALUATION AUT 11 YR 1972	FEATURE FAIRFIELD OPERATIONAL USE	SINGLE LOADING, 100 PSI CONTACT AREA		SINGLE LOADING, 24.50 IN. CONTACT AREA EACH TIME		TWIN GEAR LOADING, 100 PSI CONTACT AREA EACH TIME		TWIN GEAR LOADING, 44 IN. EACH CONTACT AREA EACH TIME		BI-CYCLE TWIN GEAR LOADING, 24.50 IN. CONTACT AREA EACH TIME
		NO.	DESIGNATION	1	2	3	4	5	6	
TWA	Taxiway 26	Capacity	155,000+	85,000+	155,000+	220,000+	200,000+	270,000	230,000+	390,000+
	Frost capacity		155,000+	85,000+	155,000+	220,000+	200,000+	270,000	230,000+	390,000+
TZA	Taxiway 21	Capacity	155,000+	80,000	110,000	140,000	130,000	200,000	130,000+	280,000+
	Frost capacity	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
T6A	Taxiway 21 (through old R- runway)	Capacity	155,000+	85,000+	155,000+	220,000+	200,000+	330,000+	230,000+	390,000+
	Frost capacity		155,000+	85,000+	155,000+	220,000+	200,000+	330,000+	230,000+	390,000+
T7A	Taxiway 17 (through old ADC alert apron)	Capacity	155,000+	85,000+	155,000+	220,000+	200,000+	330,000+	230,000+	390,000+
	Frost capacity		155,000+	85,000+	155,000+	220,000+	200,000+	330,000+	230,000+	390,000+
T8A	Taxiway 17 (through old ADC alert apron)	Capacity	155,000+	85,000+	155,000+	220,000+	200,000+	330,000+	230,000+	390,000+
	Frost capacity		155,000+	85,000+	155,000+	220,000+	200,000+	330,000+	230,000+	390,000+
T9A	Center 50 ft of taxiway 17	Capacity	155,000+	85,000+	155,000+	220,000+	200,000+	330,000+	230,000+	390,000+
	Frost capacity		155,000+	85,000+	155,000+	220,000+	200,000+	330,000+	230,000+	390,000+
T11B	Center 25 ft of MAC alert apron and taxiway	Capacity	155,000+	85,000+	155,000+	220,000+	200,000+	330,000+	230,000+	390,000+
	Frost capacity		155,000+	85,000+	155,000+	220,000+	200,000+	330,000+	230,000+	390,000+
T20C	Taxiway 22	Capacity	155,000+	85,000+	155,000+	180,000	200,000+	230,000	230,000+	380,000+
	Frost capacity	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
T23B	Center 150 ft of taxiway 25	Capacity	75,000	60,000	110,000	175,000	130,000	245,000	245,000	360,000+
	Frost capacity		55,000	45,000	80,000	125,000	95,000	150,000	170,000	290,000
T25B	Center 25 ft of taxiways 13, 14, 15, and 16	Capacity	155,000+	60,000	110,000	140,000	200,000+	220,000	230,000	360,000+
	Frost capacity		50,000	50,000	70,000	110,000	70,000	110,000	110,000	250,000
T21B	Taxiway 23	Capacity	120,000	45,000	95,000	105,000	160,000	165,000	200,000	235,000
	Frost capacity	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
T21B	Taxiway 5	Capacity	65,000	45,000	70,000	80,000	105,000	85,000	110,000	130,000
	Frost capacity	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)

(3 of 5 sheets)

EDITION OF AUG 1965 IS OBSOLETE.

WES FORM NO. 999  
JUNE 1972

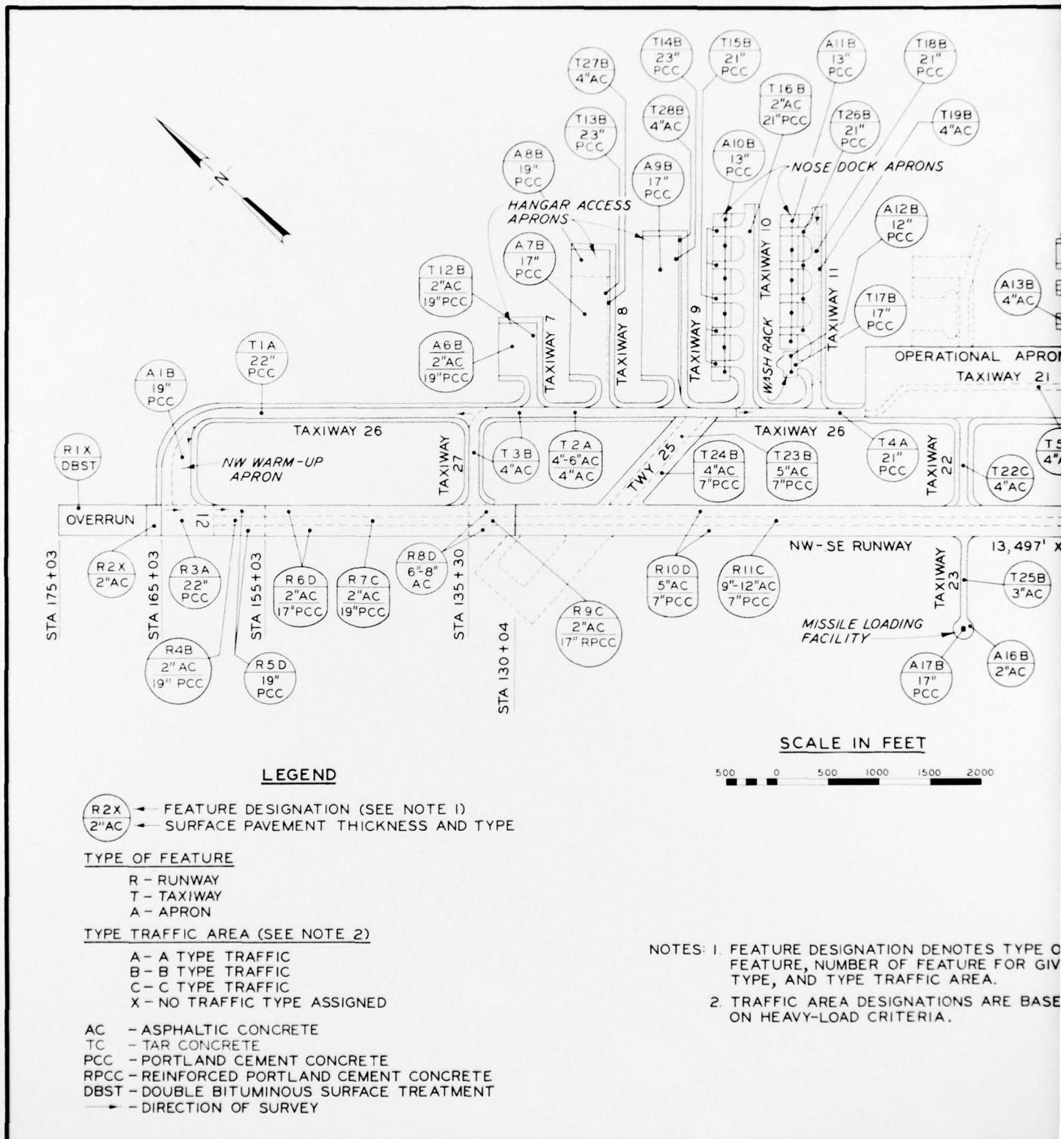
Table 4 (continued)  
SUMMARY OF PAVEMENT EVALUATION

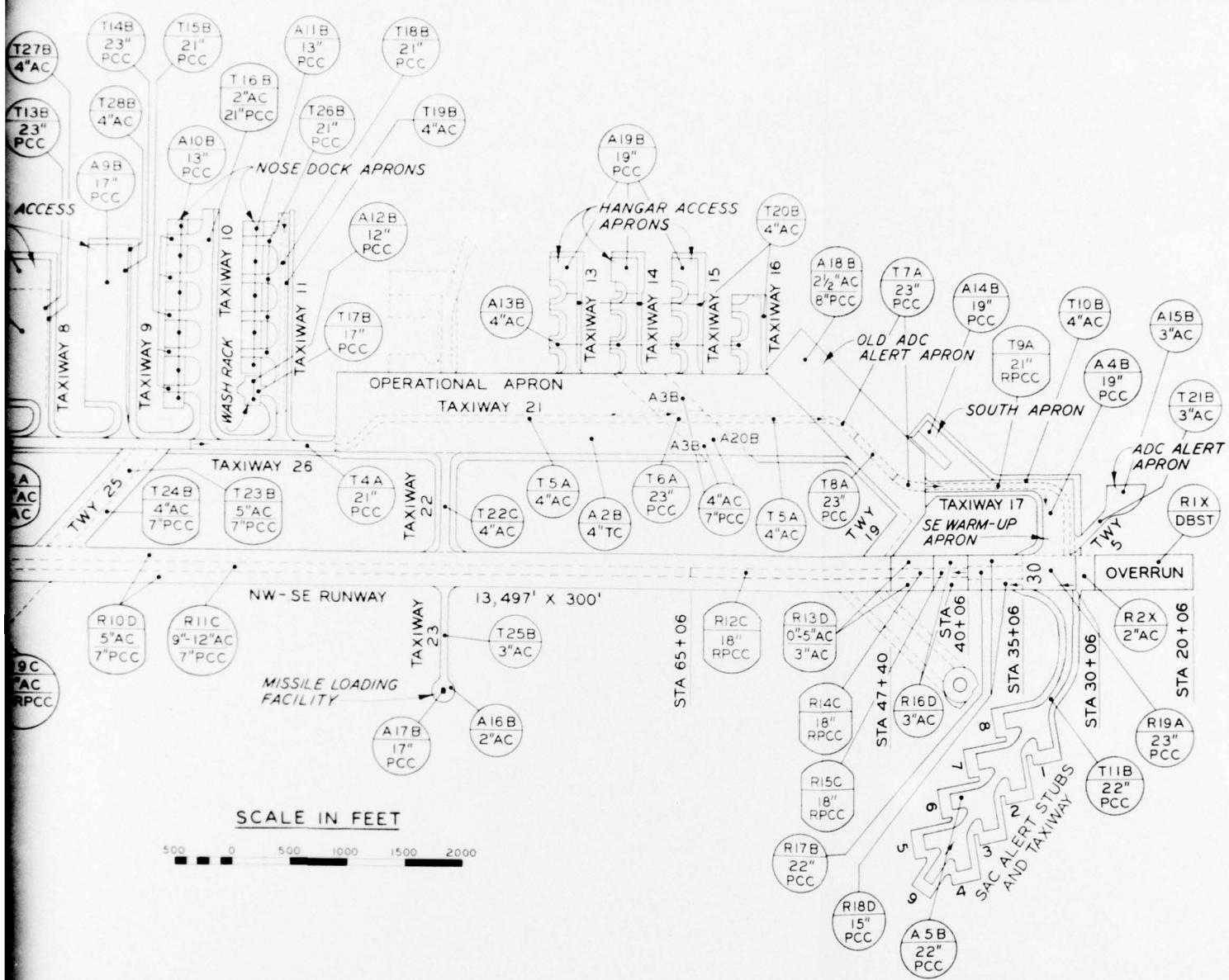
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Table 4 (Continued)  
SUMMARY OF PAVEMENT EVALUATION

NAME OF AIRFIELD S. Thos. Blawtherth AFB, Month: April Year: 1972		LOAD-CARRYING CAPACITY IN LB OF GROSS PLANE LOAD FOR INDICATED LANDING GEAR TYPES AND CONFIGURATIONS											
		TRICYCLE ARRANGEMENT											
NO.	DESIGNATION	FEATURE PAVEMENT OPERATIONAL USE	SINGLE 100-LB TIRE PRESSURE	SINGLE 100-LB CONTACT AREA	SINGLE 247-SQ-IN CONTACT AREA	TW 28-IN C-C 226-SQ-IN CONTACT AREA	SINGLE 60-IN 400-SQ-IN CONTACT AREA	TW 35-IN C-C 287-SQ-IN CONTACT AREA	TW 44-IN C-C 287-SQ-IN CONTACT AREA	TW 51-IN 33 IN. x 46 IN 208-SQ-IN CONTACT AREA	TW 58-IN 33 IN. x 46 IN 208-SQ-IN CONTACT AREA	BICYCLE	REMARKS
ACB	Old AS runway used as part of parking apron (outsize 75 ft)	Capacity Front capacity	75,000 60,000	60,000 45,000	105,000 80,000	110,000 80,000	170,000 125,000	125,000 95,000	170,000 120,000	240,000 165,000	680,000 490,000	(a) (a)	OPEN TIRE SPUG 3142-17 287 SQ-IN CONTACT AREA EACH TIME
AL43	South apron	Capacity Front capacity	155,000+ 155,000+	85,000+ 85,000+	155,000+ 155,000+	220,000+ 210,000	200,000+ 200,000+	235,000 225,000	230,000+ 230,000+	380,000+ 330,000	800,000+ 800,000+	320,000 280,000	
AL53	AC alert apron	Capacity Front capacity	65,000 (a)	45,000 (a)	70,000 (a)	80,000 (a)	100,000 (a)	85,000 (a)	115,000 (a)	330,000 (a)	450,000 (a)		
ASB	SAC alert apron	Capacity Front capacity	155,000+ 155,000+	85,000+ 85,000+	155,000+ 155,000+	220,000+ 220,000+	200,000+ 200,000+	230,000+ 230,000+	230,000+ 230,000+	380,000+ 380,000+	800,000+ 800,000+	450,000 450,000	
AL63	Loading pad, exterior portion	Capacity Front capacity	50,000 (a)	30,000 (a)	55,000 (a)	70,000 (a)	90,000 (a)	75,000 (a)	75,000 (a)	380,000+ (a)	800,000+ (a)	450,000 (a)	
AL73	Loading pad, center portion	Capacity Front capacity	155,000+ 155,000+	85,000+ 85,000+	155,000+ 155,000+	210,000 210,000	200,000+ 200,000+	235,000 235,000	230,000+ 230,000+	380,000+ 380,000+	800,000+ 800,000+	300,000 300,000	
AL8	SE warm-up apron	Capacity Front capacity	155,000+ 155,000+	85,000+ 85,000+	155,000+ 155,000+	220,000+ 220,000+	200,000+ 200,000+	238,000 238,000	230,000+ 230,000+	380,000+ 380,000+	800,000+ 800,000+	360,000 360,000	
AL8	NW warm-up apron	Capacity Front capacity	155,000+ 145,000	85,000+ 85,000	155,000+ 155,000	215,000 215,000	200,000+ 200,000	230,000 230,000	230,000+ 230,000	360,000 360,000	800,000+ 800,000	320,000 285,000	



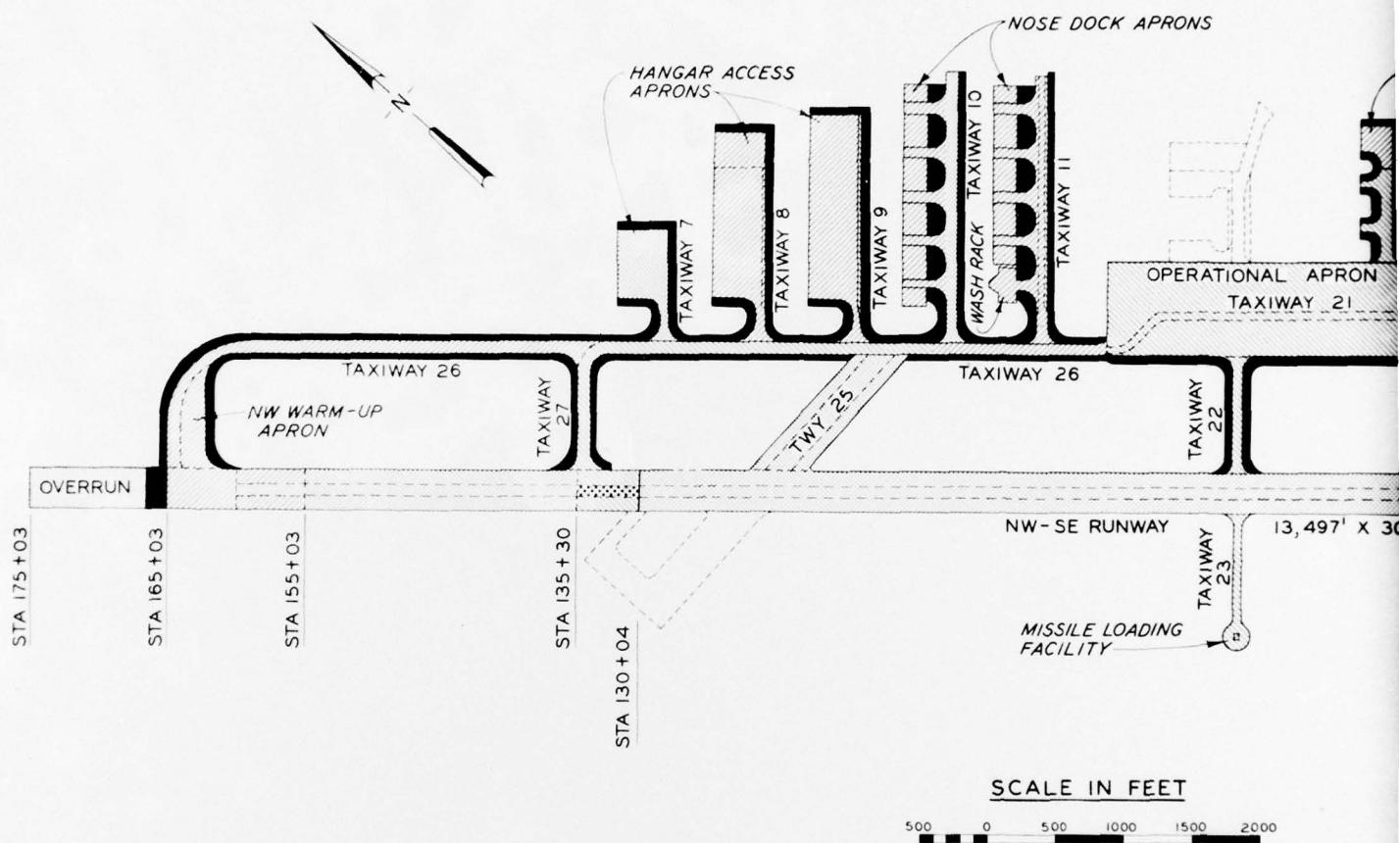


ELLSWORTH AIR FORCE BASE  
SOUTH DAKOTA

**AIRFIELD LAYOUT**

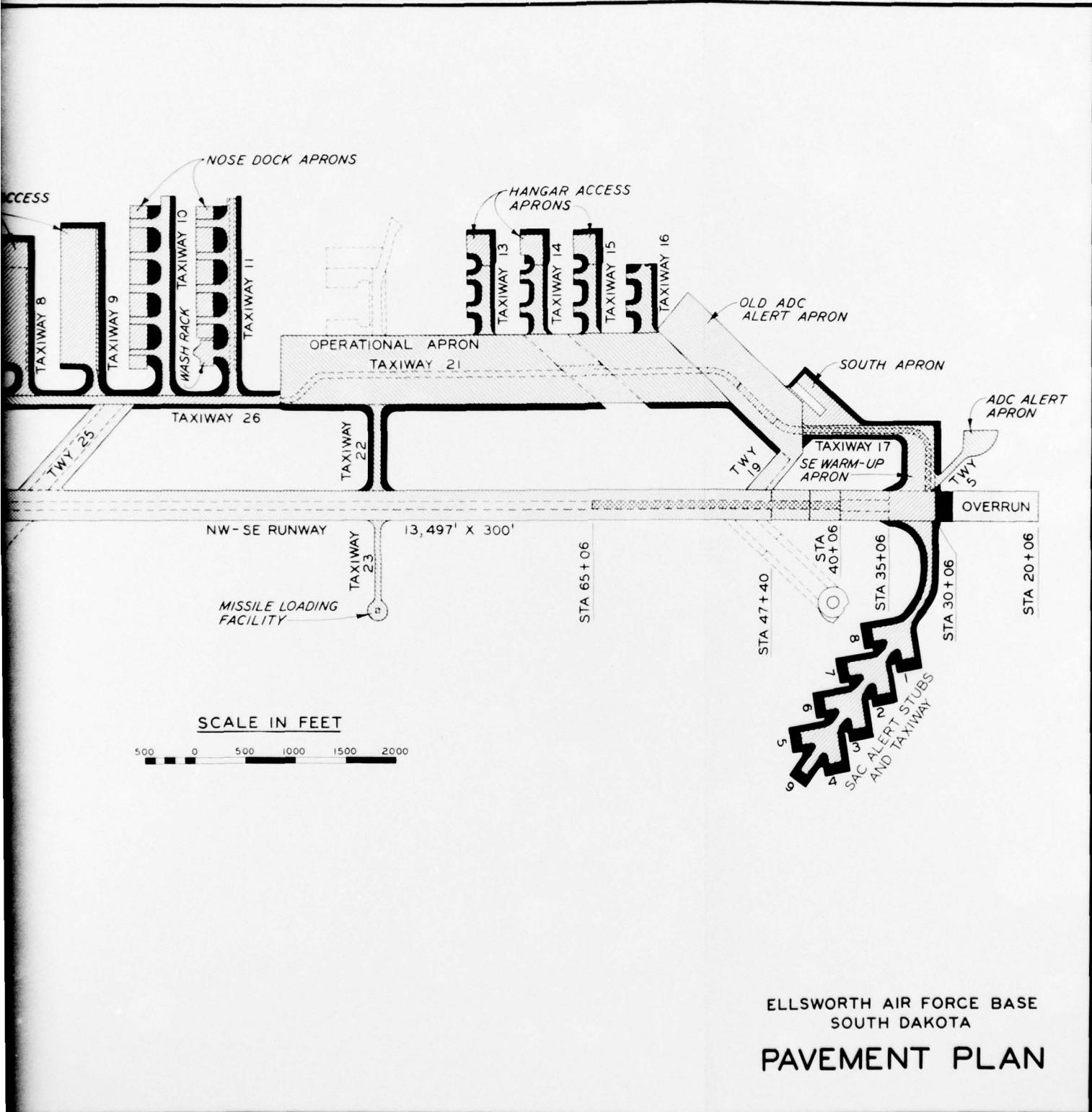
PLATE 1

2



LEGEND

- BITUMINOUS CONCRETE (AC OR TAR)
- PORTLAND CEMENT CONCRETE (PCC)
- ASPHALTIC CONCRETE (AC) OVER PORTLAND CEMENT CONCRETE (PCC)
- REINFORCED PORTLAND CEMENT CONCRETE (RPCC)
- ASPHALTIC CONCRETE (AC) OVER REINFORCED PORTLAND CEMENT CONCRETE (RPCC)
- DOUBLE BITUMINOUS SURFACE TREATMENT (DBST)
- BLAST PAVEMENT (AC-NONTRAFFIC AREA)



ELLSWORTH AIR FORCE BASE  
SOUTH DAKOTA

## PAVEMENT PLAN

PLATE 2

2

Appendix A: EAFB Annual Pavement Maintenance Plan

Facility Description	Pavement Type	Year Constructed	Existing Condition	Maintenance and Repair History	Present or Proposed Maintenance and Repair
T/W, Apron Access 14, 118 SY Total: 7,800 SY of 10-ft-wide Keel (12-in. to 22-in. PCC & 4-in. to 26-in. subbase) 27,740 SY (17-in. PCC & 4-in. filter 24-ft edge - 4-in. AC 4-in. base and 42-in. subbase)	PCC Heavy	1962	Satisfactory	Slurry Sealed Shoulder Stab 1966	Spall Repair Required
T/W, Apron Access 14, 118 SY Total: (Soft Keel Section of 22-in. to 24-in. PCC on 4-in. to 26-in. subbase. (Soft Section of 24-in. PCC 4-in. filter) 24-ft section of 4-in. AC 4-in. base, same 42-in. subbase	PCC Heavy	1962	Satisfactory	Slurry Sealed Shoulder Stab 1966	
T/W Apron Access 22, 165 SY Total: (4-in. AC on 21-in. PCC on 4-in. filter). The area between the access to stub parking and the stub parking is light-duty concrete.	PCC	1963	Satisfactory	Cracks in overlay	
Apron Access 10, Access Apron to Stub Parking	PCC	1953	Satisfactory	Apron overlayed panels 1966, Slurry sealed Shoulder Stab 66 and Pads	
T/W Apron Access 26, 135 SY Total: (10,520 SY of 20-ft Keel in 1962. 5 LF 24-in. PCC on 24-in. Base. Reminder is 21-in. PCC on 4-in. Base). The area between the Access to stub parking is light-duty concrete.	PCC	1963	Satisfactory	Pads restriped 1966 Slurry sealed Shoulder Stab 1966	
Runway N End, S End and Keel 160,000 SY (Keel-12 in. concrete, 24-in. Base and 10 in. Filter) (Shoulders- 17-in. concrete and 4-in. filter)	Rigid Heavy	Ext 49	Satisfactory	Laid Keel Section 1966, Overlayed 33,000 sq yds Asphaltic Concrete July 1966, re-striped Sep 1966 and in 1968, Repaired 1,500 ft. of spalls	ELS 18-0 to resel 3,500 ft of cracks in South end
Edges and Center Section 290, 456 SY 7-in. AC, on 7-in. PCC & 8-in. Base	Flex Heavy		Satisfactory	Slurry Sealed 292,000 SY July 1966, Sealed 56,000 LF Joints in July 1966, Restriped 1966 and 1968	ELS 18-0 Overlay Center 6,500 ft Route Old Crack and fill with slurry seal. Oct 1968
Runway Overruns 66,666 SY Total: (10,000 SY of 2-in. AC on 4-in. base and 33-in. subbase). (56,666 SY of 6-in. base and 36-in. subbase).	Flex Light	1956	Satisfactory	Chips Sealed 50,000 SY 1966, Flush Sealed 16,700 SY 1962, Restriped Chevrons 1964	
Alert T/W 17,2 Total: (22-in. PCC on 24-in. base)	Rigid Heavy	1958	Satisfactory	Sealed Joints with 200A 1968, Slurry Sealed Shoulder 1966	
Alert T/W 3,330 SY Total: (3-in. AC on 6-in. Base and 12-in. subbase). Not used for Aircraft.	Flex Light	1951	Satisfactory	No recent maintenance or repair	ELS 184-2 to seal cracks
T/W Apron Access 7,396 SY Total: (4-in. AC Overlay on 19-in. PCC on 4-in. filter)	PCC	1956	Satisfactory	Slurry Sealed Shoulder Pads with AC Overlay 1966	ELS 184-2 to seal cracks
T/W, Apron Access, 14,632 SY Total: (4 in. AC on 18 in. reinf. PCC with 12-in. 12-in. subbase). Abandoned as T/W used as road and parking.	Flex	1952	Satisfactory		
T/W, Apron Access 9,941 SY Total: (4-in. AC on 18-in. base and 29-in. subbase).	Flex	1953	Fair	Slurry Sealed 1966	
T/W, Apron Access 8,941 base and 29-in. subbase	Flex	1953	Fair	Slurry Sealed 1966	
T/W, Apron Access 8,491 SY Total: 4-in. AC on 18-in. base and 29-in. subbase	Flex	1953	Fair	Slurry Sealed 1966 30 Sq Ft spalls repaired in-house FY 67	
T/W, Apron Access 6,725 SY Total: (4-in. AC on 18-in. base and 29-in. subbase).	Flex	1953	Satisfactory	Slurry Seal 1966	
T/W, Access 22, 467 SY Total: (12,467 SY of Flex 4-in. AC on 12-in. Base and 28-in. subbase). 10,000 SY of 21-in. reinf. PCC on 24-in. base).	Flex	1950	Satisfactory	Joints Sealed 1962 Slurry Sealed Shoulder Stab 1966	
T/W, Runway Access 12,024 SY (22-in. PCC on 24-in. Base).	PCC Heavy	1958	Satisfactory	Slurry Sealed Shoulder Stab 1966, Sealed Joints 1962	
T/W, Runway Access 9,700 SY Total: (22-in. PCC on 4-in. Filter). <u>Not used by heavy aircraft.</u>	Flex	1954	Satisfactory	Slurry Sealed in 1966	

(Continued)

Facility Description	Pavement Type	Year Constructed	Existing Condition	Maintenance and Repair History	Present or Proposed Maintenance and Repair
T/W, Runway Access 4-133 SY Total: 7-in. PCC, 3-1/2-in. AC on 6-in. base-center. <u>Occasionally used for Capt. Runways.</u>	Flex	1962	Abandoned for Heavy Aircraft	Slurry Sealed in 1965	Pavement to be removed (In-house)
T/W, Runway Access 19-70 SY	Rigid Heavy	1968	Satisfactory	Restriped 1969	
Runway Access 139,264 SY (4-in. AC on 12-in. base and 28-in. subbase).	Flex Heavy	1968	Unsatisfactory	Restriped FY 69 Replaced 50-in. and 70-in. wide strip on center for entire length in FY 69	
Runway Access 9,583 SY (4-in. on 12-in. base and 28-in. subbase).	Flex	1968	Satisfactory	Slurry Sealed in 1966	
Runway Access 6,100 SY Total: (3-in. AC on 6-in. base and 15-in. subbase). <u>Used by SAC Aero Club.</u>	AC Heavy	1968	Satisfactory	Rebuilt to Accommodate Unloading Missiles 1969	
Runway Access 14,385 SY Total: (3-in. AC on 6-in. base and 15-in. subbase).	Flex Light	1968	Satisfactory	No recent maintenance or repair	ELS 108-0 to repair
Runway Access 38,187 SY Total: (6-in. AC, 7-in. PCC, 1-1/2-in. AC).	Flex Overlay Pavement	1948	Satisfactory	Slurry Sealed in June 1969. Slurry Seal 1966. Large failure at 1/2 way and repaired 1967.	
Runway Access 26,916 SY Total: (26,000 SY of 19-in. and 22-in. PCC on 12-in. base and 29-in. subbase)	Rigid	1968	Satisfactory	Repaired Longitudinal Fractures and replaced 9 fractured slabs in 1965 Minor patching in-house 1967. Repaired spills in-house FY 69.	ELS 108-0 to repair spills slabs are moving at one spot and will require repair
Runway Access (26,916 SY of 4-in. AC on 6-in. base and 40-in. subbase)	Flex	1968	Fair	Slurry Seal Shoulder Stab 1966.	
Runway Access 11,525 SY Total: (4-in. AC on 6-in. base and 40-in. subbase).	Flex	1968	Fair	Slurry Sealed 1966	
T/W 1,270 SY Total: (17-in. PCC on 4-in. filter).	Heavy	1962	Satisfactory	Wash Rack 20-ft Heavy Duty Keel Section Laid 1962	Joints to be sealed by Contracts
Runway Access 12,388 SY Total: Used only in Emergencies.	3-1/2-in. AC 7-in. PCC	Orig 1942	Satisfactory	No recent major maintenance or repair	To be removed completely (In-house)
T/W Support 7,770 SY (7-in. PCC on 8-in. base)	Rigid Light	1943	Unsatisfactory	No recent major repair	To be removed completely (In-house)
T/W Support 5,889 SY Total: (5-in. AC on 7-in.).	Rigid Light	1943	Unsatisfactory	No recent major maintenance or repair	To be removed completely (In-house)
Hanger Access and Stub Parking 16, 117 SY Total: (19-in. PCC on 4-in. filter).	Rigid	1956	Satisfactory	Placed 2-in. AC Overlay 1966	ELS 108-0 to seal cracks
Hanger Access and Stub Parking 41,670 SY Total: (19-in. PCC and 17-in. PCC on 4-in. filter)	Rigid	1955	Satisfactory	No recent Maintenance or repair	
Hanger Access and Stub Parking 37,013 SY Total: (17-in. PCC on 4-in. filter).	Rigid	1955	Satisfactory	No Recent Maintenance Replaced Repair	
Hanger Access and stub Parking 30,300 SY Total: (13-in. PCC on 4-in. filter), (21-in. PCC on 4-in. filter).	Rigid	1953	Satisfactory	Placed 2-in. AC Overlay Replaced Broken Slabs 1966. Replaced 50 x 50 AC Pad 1968	
Hanger Access and stub Parking 30, 734 SY Total: (13-in. PCC on 4-in. filter) (21-in. PCC on 4-in. filter).	Rigid	1953	Unsatisfactory	Replaced Broken Slabs 1966	ELS 108-0 to seal joints
Apron, Hangar Access 9,109 SY Total: (4-in. AC on 12-in. base and 28-in. subbase).	Flex Heavy	1960	Satisfactory		
Apron, Hangar Access 12,082 SY (19-in. PCC on 4-in. filter) <u>Used for M. Men Vehicle Parking</u>	Rigid	1962	Satisfactory	No recent major repair	
Apron Hangar Access 9,109 SY (4-in. AC on 12-in. base and 28-in. subbase). <u>Used for M. Men Vehicle Parking</u>	Flex	1960	Satisfactory	Slurry Sealed 1966	
Hangar Access Apron 1,688 SY Total: (4-in. AC on 12-in. base and 28-in. subbase).	Flex-Med	1966	Satisfactory	Slurry Sealed 1966	
Apron, Hangar Access 1,688 SY Total: (4-in. AC on 12-in. base and 28-in. subbase).	Flex-Med	1966	Satisfactory	Slurry Sealed 1966	

(Continued)

Facility Description	Pavement Type	Year Const.	Existing Condition	Maintenance and Repair History	Present or Proposed Maintenance and Repair
Apron, Hangar Access 1,000 SF Total: (10-in. PCC on 4-in. filter)	Rigid-Med	1966	Satisfactory	No recent major repairs	
Hangar Access Apron 1,000 SF Total: (4-in. AC on 10-in. base and 10-in. subbase)	Flex-Med	1966	Satisfactory	Slurry Sealed	
Apron, Hangar Access 1,000 SF Total: (4-in. AC on 10-in. base and 10-in. subbase)	Flex-Med	1966	Satisfactory	Slurry Sealed 1966	
Apron, Hangar Access 1,000 SF Total: (10-in. PCC on 4-in. filter)	Rigid-Med	1966	Satisfactory	No recent major repair	
Hangar Access Apron 2,000 SF Total: (10-in. PCC on 4-in. filter)	Rigid-Med	1966	Satisfactory	No recent Maintenance	
Hangar Access Apron 1,000 SF Total: (4-in. AC on 10-in. base and 10-in. subbase)	Flex	1966	Satisfactory	Slurry Sealed in 1966	
Loading Apron 14,000 SF Total:	Rigid	1966	Satisfactory	No Recent Maintenance or Repair	
Loading Apron 34,000 SF Total: (7-in. PCC, 3-1/2-in. or 1-1/2-in. AC on 6-in. - 8-in. base) <u>To be Abandoned</u>	Rigid-Lt	1963	Unsatisfactory	No Recent Maintenance Repair	To be Completely removed (In-house)
Operational Apron 81,000 SF Total: (4-in. AC on 10-in. base and 27-in. base)	Flex Heavy	1966	Satisfactory	Constructed 14 Hardstands 1965, Slurry Sealed shoulder Stab 1966. Slurry Sealed.	Asphalt at Parking Spots need repairing.
Operational Apron 79,000 SF Total: (2-1/2-in. AC on 7-in. PCC)	Rigid-Over laid with AC Heavy	1942	Unsatisfactory	Slurry Sealed 1967. Repaired Keel transition 1966	
Base Flight 21,676 SF Total: (4-in. AC on 12-in. base and 27-in. subbase)	Flex Heavy	1966	Satisfactory	No Recent Maintenance or Repair	
Trans Ent 22,801 SF Total: (4-in. AC on 12-in. base and 27-in. subbase)	Flex Heavy	1966	Satisfactory	No Recent Maintenance or Repair	
Shoulder Stab 365,914 SF Total: (3-in. AC on 6-in. base and 9-in. - 15-in. subbase)	Flex-Lt	1942	Satisfactory		
Hardstand Calc 6,683 SF Total: (20-in. PCC or 3-1/2-in. AC on 6-in. base) <u>Used in Emergencies Only</u>	Rigid Overlaid	1954	Satisfactory		To be Completely removed (In-house)
Hangar Access Apron 1,000 SF Total: (4-in. AC on 10-in. base and 10-in. subbase)	Rigid-Med	1966	Satisfactory	Slurry Sealed 1966	
Hangar Aprons 1,688 SF Total: (4-in. AC on 10-in. base and 10-in. subbase)	Flex-Med	1966	Satisfactory	Slurry Sealed 1966	
Hangar Aprons (Access) 1,688 SF Total: (3-in. AC on 6-in. base and 15-in. subbase)	Flex-Med	1966	Satisfactory	Slurry Sealed 1966	
Apron Hangar Access 3,250 SF Total: (3-in. AC on 6-in. base and 15-in. subbase)	Flex-Med	1962	Satisfactory	Slurry Sealed 1967	
Apron Hangar Access 19,489 Total: (1-in. PCC on 4-in. filter)	Rigid	1967	Satisfactory	Slurry Sealed 1967	
Apron Hangar Access 7,300 SF Total: (3-in. AC on 6-in. base and 15-in. subbase)	Flex-Med	1961	Satisfactory	No Recent Major Repair	ELC 100-4 to seal cracks
Apron Hangar Access 16,605 SF Total: (7-in. PCC or 4-in. AC) <u>Hangar and Apron used by NAC Aero Club</u>	Flex	1960	Unsatisfactory	No Recent Major Repair	ELC 100-4 to repair
Power Check Pad 14,613 SF (10-in. PCC on 4-in. filter)	Rigid-Med	1966	Satisfactory	Sealed Joints 1961 Slurry Sealed shoulder Stab 1966	ELC 100-4 to repair spills
Power Check Pad 11,500 SF (10-in. PCC on 4-in. filter)	Rigid-Med	1966	Satisfactory	Sealed Joints 1961 Slurry sealed shoulder Stab 1966	ELC 100-4 to repair spills
Corrosion Control 4,579 SF Total: (12-in. PCC on 4-in. filter)	Rigid-Med	1954	Satisfactory		